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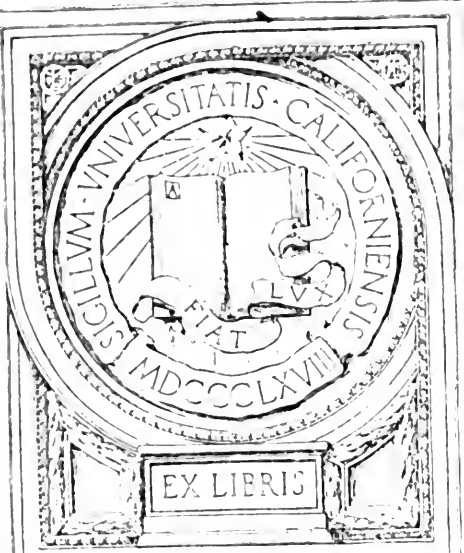
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IMPERIAL GEOLOGICAL SURVEY OF JAPAN

WITH

A CATALOGUE OF ARTICLES

EXHIBITED AT THE

PANAMA-PACIFIC INTERNATIONAL EXPOSITION

HELD AT

SAN FRANCISCO, UNITED STATES OF AMERICA

IN

1915

THE IMPERIAL GEOLOGICAL SURVEY OF JAPAN

DEPARTMENT OF AGRICULTURE AND COMMERCE

TŌKYŌ, 1915

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IMPERIAL GEOLOGICAL SURVEY OF JAPAN

HISTORY

The first geological examination of Japan (exclusive of the Hokkaidō, Ryūkyū, Taiwan, Karafuto, and Chōsen)[1] was made by Mr. T. WADA, in 1878, under the Geographical Bureau (*Chiri-kyoku*) of the Department of Interior, the provinces of Kai and Izu being then mapped out. At the end of the same year, Dr. EDMUND NAUMANN, then Professor of Geology in the Tōkyō University, advised the establishment of a systematic geological survey of the Empire, and submitted a plan for the same to the Minister of the Department of Interior. Almost at the same time Mr. T. WADA, then Assistant Professor in the Science College, submitted to the Government his plan for the geological survey, which was almost coincident with that of Dr. E. NAUMANN. In May 1879, their plan was adopted and the present Imperial Geological Survey was organized and put into operation under the management of Mr. T. WADA, the scientific staff being placed under the direction of Dr. E. NAUMANN. As much time was spent in making the necessary preparations, the survey itself was not begun till the following year. In 1881, the Government established the Department of Agriculture and Commerce (*Nōshō-mushō*), and transferred to it the direction and work of the Geological Survey as a section of its Agricultural Bureau; but in 1882, the Geological Survey was made independent of this

[1] For the geological survey of the Hokkaidō, Taiwan, Karafuto, and Chōsen see Appendix.

Bureau, under the name of *Chishitsuchosajo* (Imperial Geological Survey). It was now felt, in the interests of industries rapidly developing in the Empire, that, as far as possible, the investigations carried out under the Survey should be directed to matters promising to be of practical importance, such as the examination of ore deposits, arable soils, and other forms of mineral wealth, with the object of affording assistance to mining, agriculture, and other branches of applied science. The Survey was organized in accordance with this view and Mr. T. WADA was made Director. The work in the Topographical and Geological Sections was placed under the immediate control of Dr. E. NAUMANN,[1] while the Agronomical and Chemical Sections were under the charge of Prof. Dr. M. FESCA[2] and Mr. O. KORSCHELT respectively. In 1885, the late Dr. T. HARADA succeeded Dr. E. NAUMANN, in the direction of the Geological and Topographical Surveys, and since 1884, the work of the Chemical Laboratory has been under the direction of Mr. J. TAKAYAMA who succeeded Mr. O. KORSCHELT. In 1891, ill health obliged Dr. T. HARADA to resign his office and in 1893, Mr. T. WADA having retired, Mr. T. KOCHIBE, then Chief of the Geological Section, was appointed Director. In 1894, Prof. Dr. M. FESCA was relieved of his office and pensioned in recognition of his valuable services extending over a period of twelve years. Thus the work of the Survey, which for a number of years had been carried on with the assistance of foreign experts, came now wholly into the hands of our nationals. In July 1900, a staff for the detailed survey of oil lands was organized as a department of the Survey, and in December 1903, was amalgamated with the Survey. In March 1904, the Agronomical Section was transferred to the Agricultural Experimental Station as a department of the same. In July of the same year, Mr. T. KOCHIBE having retired, Mr.

[1] At first Mr. O. SCHMIT was the Chief Topographer but for only two years.

[2] Dr. LIEBSCHER directed the work of the Agronomical Section prior to Prof. Dr. FESCA, but for only one year.

T. SUZUKI, then Chief of the Geological Section, was appointed Director. In the same month the Survey was united with the Mining Bureau. In March 1907, Mr. T. SUZUKI having retired, Mr. K. INOUYE, then the geologist and Chief of the Topographical Section, was appointed Director. In April 1910, a Staff for Mineral Surveying was newly organized as a department of the Survey, and is now engaged in the mineral survey of the Hokkaidō. In July 1913, the Oil Land Survey, which was organized in 1900, was discontinued.

The Survey has sent delegates to the International Geological Congress, the delegates being

T. WADA, the 3rd. I. G. C. (Geneva, 1885)
T. KOCHIBE and N. TSUNETŌ, the 7th I. G. C. (St. Petersburg, 1897)
T. KOCHIBE, „ 8th „ „ „ (Paris, 1900)
K. INOUYE, „ 9th „ „ „ (Vienna, 1903)
T. IKI, „ 10th „ „ „ (Mexico, 1906)
K. INOUYE, „ 11th „ „ „ (Stockholm, 1910)
K. INOUYE, „ 12th „ „ „ (Toronto, 1913)

The Survey received a gold medal at the Vienna Exposition, in 1885, for its exhibition of topographical maps; gold and silver medals at the Paris Exposition, in 1889, for its series of geological, agronomical and topographical maps; and three medals at the World's Columbian Exposition, in 1893, for its exhibits of maps, and typical specimens of soils, minerals, rocks, and fossils. Also, at the Brussels Exposition in 1897, and at the Paris Exposition in 1900, gold medals and "grand prix"; at the Louisiana Purchase Exposition in 1907, "grand prize"; at the Japan-British Exhibition in 1910, "diploma hors concours" were respectively awarded for its various exhibits.

ORGANIZATION AND FUNCTIONS

According to the original plan adopted by Dr. E. NAUMANN, the objects of the Imperial Geological Survey of Japan were to be :—

1. A topographical survey of the whole of Japan except the Hokkaido : the construction of maps and sections showing the relation and distribution of the different formations, and illustrating the geological structure of the country.

2. An agronomical survey : the construction of maps, showing the characters and positions of soils, and an examination of the soils with the view of preserving and improving their fertility, especially an agronomical survey of those portions of the country not yet under cultivation, but likely to be fit for cultivation ; and an inquiry into the quality, abundance and accessibility of such mineral fertilisers as might be found.

3. An examination of ores and coals, of deposits of such materials as might prove useful in the arts and manufactures, of building-stones and materials necessary for other technical purposes.

The scale of the maps as published was to be 1 : 200,000. The single division maps, corresponding to divisions of degree-rectangles, were to extend over 1° of longitude and $\frac{1}{2}$° of latitude. This would make 97 division maps altogether (97 topographical, 97 geological and 97 agronomical maps).

Upon economic and other grounds, Dr. E. NAUMANN's plan has been modified to the following extent. Besides the separate topographical and geological sheet-maps (scale 1 : 200,000), reconnaissance maps on a scale of 1 : 400,000, are published, which give the general topographical and geological features of the whole country. The scale of 1 : 200,000 for the agronomical maps, being too small to show the distribution of the different kinds of soils in sufficient detail, it has been changed to that of 1 : 100,000. Since the agronomical survey is frequently carried out to meet

the wants of a particular prefecture, the maps are made to extend over a *Ken* or *Fu* (prefecture), instead of being determined by longitudes and latitudes. To each geological or agronomical map, an explanatory text is attached. Besides, detailed extra-surveys, geological and agronomical, are often carried out either voluntarily or by request, the results of these surveys being mostly published as maps and reports. Bulletins and Reports are frequently published, comprising the results of either geological, agronomical, or chemical investigations conducted by the Survey.

The numbers and classes of technical officials of the Imperial Geological Survey at the end of each fiscal year, during the last ten years, have been as shown in the following table.

STAFF OF TECHNICAL OFFICIALS

	Geologists	Topographers	Chemists	Cartographers	Total
1905	8	4	4	4	20
1906	9	4	5	6	24
1907	12	3	7	6	28
1908	12	4	7	8	31
1909	12	4	7	8	31
1910	12	4	7	6	29
1911	10	2	6	5	23
1912	9	3	5	4	21
1913	8	2	5	4	19
1914	8	1	3	5	17

PERSONNEL OF THE IMPERIAL GEOLOGICAL SURVEY WITH THE OFFICIALS OF THE MINERAL SURVEY

(December 1914)

DIRECTOR:

Kinosuke Inouye

GEOLOGICAL SECTION:

Yonosuke Otsuki	(*Geologist*)	Seijirō Noda	(*Geologist*)
Giichiro Kobayashi	(,,)	Yōzō Okamura	(,,)
Shinji Yamane	(,,)	Kyūkichi Watanabe	(,,)
Denzō Satō	(*Collaborator*)	Naokichi Endō	(*Adjunct*)
Sukeyoshi Nakano	(*Adjunct*)		

CHEMICAL SECTION:

Seigo Shimizu	(*Chief*)	Toshio Ōhashi	(*Assist. Chemist*)
Kinzō Takayanagi	(*Assist. Chemist*)	Matao Hotta	(,,)

TOPOGRAPHICAL SECTION:

Topographers and Cartographers		Teruchika Nakamura	
Kenkichirō Ota		Yoneo Horiuchi	
Kōkichi Kawai		Noboru Iizuka	
Jiro Ushizawa		Kaoru Yasumuro	
Yuta Aoki		Ryuichi Miyauchi	
Hideo Yamada		Heizaburō Wakabayashi	(*Collaborator*)

The Survey is now divided into three Sections, viz.: I. Geological; II. Topographical; III. Chemical.

I. GEOLOGICAL SECTION

The scope of the Geological Section provides for a systematic geological examination of the whole country directed to

economic requirements. The work of the Section accordingly ranges itself under the five following heads: 1. Field work. 2. Office work. 3. Production and publication of maps. 4. Preparation and publication of explanatory texts, bulletins, etc. 5. museum.

1. *Field work*:—The geologist examines as accurately as possible the geology of a region selected by the Survey. Having in his hands the topographical maps and route-sketches prepared by the topographers, he adds to them detailed information as to the important geological facts perceived in those regions. Economic mineral deposits or products receive special attention and are examined more exactly. When necessary, he makes sketches of the routes or districts he has travelled and supplies data for the construction of geological maps to be published.

The time allotted for the field work of one geologist for making the survey for one sheet-map, is generally 3 or 4 months. For such work, as the examination of important mining districts; the sources of water-supply; the investigation of districts which have been devastated by an earthquake, a volcanic eruption or a landslip; the proposed locality for a dockyard or harbour, etc., a more detailed survey is carried out with more accurate instruments.

2. *Office work*:—The specimens collected in the course of the field work are examined physically, microscopically, and chemically, in order to determine their mineralogical, lithological, and palæontological characters and relations, their geological formation, position, and age, and their possible uses in the arts. The analysis of minerals and rocks, and the assay of ores and other useful substances are however handed over to the Chemical Section. The geologist has next to construct a geological map of the surveyed region with help of route-sketches and the base maps already alluded to. The geological profiles are constructed on either a true or an exaggerated scale as will best

serve the purpose. The map thus prepared becomes the basis of the geological map as published.

3. *Production and publication of maps*:—As has already been mentioned, there are two series of geological maps. The one is on the scale of 1 : 400,000, and represents the general geological features of the land; the other, known as the special map or sheet, is on the scale of 1 : 200,000. Upon this the geological formations are delineated in different colours, and the localities of materials of any economic importance are indicated by conventional signs. The sheet thus prepared, is signed by the geologist, who is responsible for the work. Both maps are published separately in Japanese and English. Detailed geological maps on a larger scale are also produced when needed for the purposes of the survey.

4. *Preparation and publication of explanatory texts, bulletins, etc.*:—The explanatory text, which is supplied with each geological sheet-map, is written in three chapters. The first treats of the topographical features of the district; the second gives a detailed description of rocks and different geological formations; and the third contains a description of any economic mineral matters. Many profiles, sections and maps are usually included in, or appended to these descriptive texts. The explanatory text is published only in Japanese.

Reports, bulletins, and memoirs, which contain notes of geological surveys and investigations conducted by the Section, are also frequently published by this Section in co-operation with some other of the Sections. The reports are in Japanese, the bulletins in Japanese with resumé in one of the European languages and the memoirs in one of the European languages.

5. *Museum*:—The specimens of rocks, minerals, fossils, ores, etc., collected by the Geological Section, are properly arranged together with geological maps and sections in the collecting room or museum. Among these, specimens of technically important materials, such as ores, building or ornamental stones,

whetstones, inkstones, oils, coals, clays, etc., are particularly arranged under separate heads.

II. TOPOGRAPHICAL SECTION

The object of this Section is to make topographical maps upon which the geological and topographical features of the country are represented with a reasonable degree of accuracy. The operations of this Section may be classified as :—1. Field work. 2. Office work. 3. Production and publication of maps.

1. *Field work :*—The topographer is usually required to plot the field sheets on the scale of 1 : 50,000, and is provided with perambulater, plane table with its requisites, pocket alt-azimuth instrument, and mercurial and aneroid barometers. The distances are directly drawn upon the plane table sheets in the field ; the heights of mountains, etc., are measured with the alt-azimuth instrument and those of the routes with the barometers. Sketches of profile views of mountains and hills, are taken when necessary. For a detailed survey, theodolite, level, magnetometer, sextant, chronometer, chain, steel tape, etc., are included in the equipment. When necessary, triangulation is carried out and field sheets are plotted on a scale much larger than the one above mentioned.

2. *Office work :*—The field sheets are reduced and drawn on the required scale of the special maps or sheets on the scale of 1 : 200,000, and also of some other maps. The heights are calculated from the altitude observations and barometrical readings. The astronomical information is supplied from the data furnished by the Trigonometrical Survey of Military Survey Department and also from the observations of the Hydrographical Office under the Department of Navy.

3. *Production and publication of maps :*—The topographical maps are published on two different scales, one on the scale of 1 : 200,000, and the other 1 : 400,000. Both are constructed

after the modified Flamsteed's projection. The middle meridian is laid down at 136° to the east of Greenwich, and the middle parallel, 36 north latitude. Each of the sheets on the scale of 1 : 200,000 extends over one degree of longitude and half a degree of latitude; and it receives as a heading the name of the most important place, such as town, mountain, etc., which it contains. The enumeration of the sheets is made by a double table, with Roman figures in the zones and Arabic in the columns. Contours are at equidistant curves of 40 meters. When finished, it will comprise 98 sheets (the Hokkaidō, Ryūkyū Islands, Taiwan, Karafuto and Chōsen excluded). The maps on the scale of 1 : 400,000 are of five divisions, commencing from the north, and each comprising three degrees of longitudes and four degrees of latitudes. Contours are of 100 meters vertical intervals, and the elevation of principal towns, mountains, etc., is written and given in meters. The various natural and artificial objects are illustrated by different conventional signs. The base is printed black, the water blue and the contour lines grey. Two scales are given below the border, one in kilometers and the other in *ri* (1 *ri*=3.927 km.). Both maps are published both in Japanese and English; and they are lithographed.

Topographical maps on various scales, necessary as base of geological maps of the Survey are also prepared by this Section.

III. CHEMICAL SECTION

The work of the Chemical Section is to make analyses of the minerals and rocks, and assays of the ores collected by the Geological Section. Experimental trials and investigations of raw materials and of their refined products from chemical and metallurgical works, the valuation of building materials, etc., are made, and the results are published as information useful in relation to scientific and industrial progress in the Empire.

WORK

The work conducted by each Section of the Survey is summed up in what follows.

I. GEOLOGICAL SECTION[1]

The reconnaissance survey of the first proposed five divisions has been completed and maps of these divisions have been published. They are now being revised, and four divisions have already been published.

Out of 98 special survey sections or sheets, the following 89 sheets have been published: Izu in 1885; Yokohama, Chiba, Shizuoka, Fuji, and Maebashi in 1887; Kazusa, Tōkyō, Kōfu, Mito, Ueda, and Nagano in 1888; Nikkō, Kitsuregawa, Toyohashi, Yokkaichi, and Sado in 1889; Asuke, Nagoya, Toyama, and Ishinomaki in 1890; Shirakawa, Ogashima, Ōsaka, Aizu, and Ichinoseki in 1891; Akita and Fukuoka in 1892; Noshiro, Miyazu, Hieizan, Ikuno, and Toyooka in 1893; Tokushima, Akō, and Kumamoto in 1894; Oki, Oita, Okayama, Tobishima, Hamada, Fukushima, and Yahiko in 1895; Kagoshima, Daisen, Sambeyama, and Honjō in 1896; Yoneyama and Fukui in 1897; Marugame, Shibushi, and Sakata in 1898; Saga in 1899; Miyazaki, Sukumo, and Susaki in 1900; Uwajima, Kōchi, and Wakayama in 1901; Koshikijima, Tsunoshima, and Kamaishi in 1902; Kinomoto and Nachi in 1903; Sadowara, Toba, and Murotozaki in 1904; Susa, Yamaguchi, and Shinjō in 1905; Suzumisaki in 1906; Hitoyoshi, Sendai, Aomori, Wajima, Suōnada, and Kamiagata in 1907; Shimoagata in 1908; Hiwasa, Iki, and Kaseda in 1909; Matsuyama in 1910; Hiroshima and Ichinohe in 1911; Shichinohe, Kanazawa, Kiso, and Nagasaki in 1912; and Hirado and Fukae in 1913.

A general geological map of the Japanese Empire on the scale of 1 : 1,000,000 in Japanese, was published in 1899, the

[1] Refer Pl. I. (at the end of this work).

English edition in 1902, and also geological map and mineral map of the Japanese Empire on the scale of 1 : 2,000,000 both in Japanese and English were published in 1911. Mineral maps in five divisions on the scale of 1 : 400,000 both in Japanese and English were planned to be issued after 1911, and two divisions, III and IV, have already been published. There have already been published 46 Reports, 37 Bulletins in 24 volumes, and 2 Memoirs, besides, special reports and maps published separately.

The decrease in the number of special sheets published in some years, is due to the greater demands upon the time of the Survey necessary to meet official and private requests for various detailed surveys. These extra-surveys are becoming still more numerous with the extension of mining and other industries. Some of these detailed surveys made since 1900 whose results have been mostly published either in bulletins, reports or in special reports, are as follows :

1900. Investigation of the eruption of the volcano Numajiri-yama in the province of Iwashiro ; of landslips in the Handa mining district in the province of Iwashiro ; geological researches in Kōjyōi Island, Chōsen ; examination of the source of the water-supply of Moji ; of the geology of the sea-bottom near the Yokohama custom-house (continued from 1899) ; of the geology of the sea-bottom of the area proposed for the construction of a harbour in the Tōkyō Bay.

1901. Prospectings for petroleum in the provinces of Inaba and Uzen, and in the Hokkaidō ; geological investigation of the sea-bottom of the area proposed for the construction of a harbour in the Tokyō Bay (continued since 1900).

1902. Investigation of building stones in the provinces of Inaba, Suo, Shimotsuke and Rikuzen ; of the geology of the sea-bottom of the area proposed for the construction of a harbour in the Tokyo Bay (continued since 1900) ; of the water-bearing strata in the neighbourhood of the Kofu railway station in the province of Kai ; of the site for a reservoir in Shimonoseki

in the province of Nagato; of the hot-spring of Takeo in the province of Hizen; of the magnetite deposit of Dorogawa in the province of Yamato.

1903. Examination of the alluvial gold district in the province of Tokachi; of the Chūgoku mine in the province of Aki; of the tungsten deposit of Kurasawa in the province of Kai, and of the Toguchi gold mine in the province of Hizen; of the oil fields of the Hokkaidō; investigation of the Yamanaka hot-spring in the province of Kaga; and of the geology of the environs of Inokashira-*ike* near Tōkyō, for the construction of a reservoir.

1904. Investigation of the Akayu hot spring in the province of Uzen; of the Hashidate gold mine in the province of Echigo; of the clayslate of Okachibama in the province of Rikuchū; of the Imogawa silver lead mine in the province of Uzen; of gold districts in the provinces of Suruga, Kōzuke, Shimotsuke, Iwaki, Shinano, Rikuzen, Rikuchū; of granite in the province of Hitachi; reconnaissance survey of the geology and mineral resources of southern Manchuria and Chōsen; of the coal fields in the province of Iwaki.

1905. Reconnaissance survey of the geology and mineral resources of southern Manchuria and Chōsen; investigation of gold districts in the provinces of Hizen, Rikuzen and Rikuchū.

1906. Investigation of the landslips of Ōdera in the province of Uzen; of irrigation in the vicinities of Nakayama in the province of Musashi; of the Ureshino hot spring in the province of Hizen; geological survey of the Bibai and Naie coal fields in the Hokkaidō; of phosphate deposits in the province of Noto.

1907. Detailed geological survey of copper districts in Shikoku; of the volcanoes in Kyūshū; of the Tertiary of Yamakita in the province of Sagami; geological survey of the Yebara and Toyotomi copper mines in the province of Tanba; examination of the railway line between Niitsu in the province of Echigo and Kitakata in the province of Iwashiro; of the landslips of Kōzushima, belonging to the province of Musashi, of Hibaramura

in the province of Musashi, and of Tanogōri in the province of Kōzuke; investigation of gold production in Kyūshū; reconnaissance survey of the geology and mineral resources of Kantō.

1908. Detailed geological survey of the volcanoes in Kyushū; of the middle part of the Naibuchi coal field in Karafuto; examination of the hot springs of Wagura in the province of Noto and of Yumoto in the province of Iwaki; of the salt springs in the provinces of Shinano and Iwashiro.

1909. Geological survey of the oil fields, of Yoneyama, Gōzu, and Hiyama in the province of Echigo; of the volcanic groups of Kujūsan in the province of Hyūga, and of Kirishima-yama in the province of Satsuma; of the Imperial Domain of Kiso in the provinces of Mino, Hida and Shinano; detailed geological survey of the Matsushima coal field in the province of Hizen; examination of the Yumoto hot spring in the province of Iwaki; of the earthquake in the provinces of Mino and Omi; of the eruptions of the volcano Tarumae in the Hokkaidō; of the volcano Asama in the province of Shinano; of the new crater of the volcano Aso in the province of Higo; of experiments with the water sources in the several parts of the province of Hitachi.

1910. Geological survey of the oil fields of Ushirodani and Mitsuke in the province of Echigo; of the volcanoes, of Sakura-jima and Kaimon, in the province of Satsuma; detailed geological survey of the Karatsu coal field in the province of Hizen; of the southern part of the province of Izu; examination of the Yumoto hot spring in the province of Iwaki; of the eruption of the volcano Usu in the Hokkaidō, of the water supply of Ōiso and Kawasaki in the province of Sagami.

1911. Detailed geological survey of the volcano Unzen in the province of Hizen; of the volcano Yufudake in the province of Bungo; of the Oki Islands; reconnaissance geological survey of the manganese deposits in the province of Tanba; examination of the water supply of Nakano and Ōi in the province of

Sagami; of the landslides of Murayama in the province of Iwashiro; of Okinoshima in the province of Awaji; of the inundation in the province of Kai.

1912. Geological survey of the Nagamine oil field in the province of Echigo; of the Momoyama Imperial Domain in the province of Yamashiro; detailed geolgical survey of the volcano Kujūsan in the province of Bungo; of the Taniyama tin mine in the province of Satsuma; examination of the eruption of the volcano Miharayama in the province of Izu; of the several hot springs in the province of Uzen; of the hot springs and gas wells of Kamisuwa in the province of Shinano; of the districts along the railway near Narugo in the province of Rikuzen.

1913. Geological survey of the western part of the province of Iyo; of the middle part of the province of Izu; of the Yamagano mining district in the province of Satsuma; detailed geological survey of the Iwaki coal field in the province of Iwaki; examination of the volcano Sakurajima in the province of Satsuma; of the Ōwani, Kuradate, and Ikarigaseki hot springs in the province of Mutsu; of the Yumoto hot springs in the province of Iwaki; of the Yugawara and Mihomura hot springs in the province of Sagami; of the Dōgo hot spring in the province of Iyo; of the water supply of the Tsukui district in the province of Sagami, and of Sakai in the province of Izumi; of the landslides at Hayama in the province of Sagami.

II. TOPOGRAPHICAL SECTION[1]

The field work of the Topographical Section has been so conducted as to be one step in advance of that of the Geological Section. The reconnaissance maps which were first proposed, have been published, and are five in number. They are now being revised and four divisions have already been published.

[1] Refer Pl. II (at the end of this work).

Out of 98 special maps or sheets 94 have been issued. They are now being revised, 2 sheets having already been published. The sheets published are as follows:

Special Sheets (in Japanese and English): Izu, Yokohama, and Kazusa, in 1884; Tōkyō, Chiba, and Shizuoka, in 1886; Fuji, Kōfu, Maebashi, and Mito, in 1887; Ueda, Nagano, and Nikkō, in 1888; Kitsuregawa, Toyohashi, Yokkaichi, and Sado, in 1889; Asuke, Nagoya, Toyama, and Ishinomaki, in 1890; Shirakawa, Ogashima, Osaka, Aizu, and Ichinoseki, in 1891; Akita, Fukuoka, Noshiro, Miyazu, and Hieizan, in 1892; Ikuno, Toycoka, Kumamoto, Tobishima, and Hamada, in 1893; Tokushima, Akō, Ōita, Fukushima, Yahiko, and Okayama, in 1894: Sambeyama, Daisen, Oki, and Kagoshima, in 1895; Honjō Yoneyama, and Fukui, in 1896; Marugame, and Sakata, in 1897; Shibushi, Saga, and Wakayama, in 1898; Miyazaki, Sukumo, and Kōchi, in 1899; Susaki, Uwajima, and Kamaishi, in 1900; Koshikijima, and Tsunoshima, in 1901; Kinomoto, and Nachi, in 1902; Shinjō, Toba, and Sadowara, in 1903; Susa and Murotozaki, in 1904; Yamaguchi, in 1905; Sendai, Kaseda, Suzumisaki, and Hitoyoshi, in 1906; Aomori, Wajima, Suōnada, Kamiagata, Shimoagata, and Iki, in 1907; Kanazawa, Nobeoka, Matsuyama, and Hiwasa, in 1909; Ichinohe and Hiroshima, in 1910; Hirado, Shichinohe, Kiso, Nagasaki, and Tsuruga, in 1911; Izu (revised), in 1912; Fukae, Shiriyasaki, Murakami, and Tōkyō (revised), in 1913.

Topographical map of the Japanese Empire on the scale of 1 : 1,000,000 (in Japanese), in 1897. The same in English, in 1899.

Detailed topographical surveys were carried out in the oil field in Yurigōri in the province of Ugo, in 1900; in the Hōtoku mine in the province of Inaba, in 1901; in the coal fields of Amakusa-shimoshima in the province of Higo, and in the iron ore district of Dorogawa in the province of Yamato, in 1902; in the Chūgoku mine in the province of Bizen, in 1903: in the

coal fields in Hitachi and Iwaki, in 1904; in the coal fields of Karatsu in the province of Hizen and of Naibuchi in Karafuto, in 1908; in the Kurokawa oil field in the province of Ugo; in the environs of the Yumoto hot spring in the province of Iwaki; and in the Matsushima coal field in the province of Hizen, in 1909; in the southern part of the province of Izu; and in the Iwaki coal field in the province of Iwaki, in 1910; in the Suzuyama tin mine in the province of Satsuma, in 1911; in the volcano Miharayama in the province of Izu and in the Iwaki coal field in the province of Iwaki, in 1912; and in the Yamagano mining district in the province of Satsuma, in 1913.

III. CHEMICAL SECTION

The results of analyses of rocks, minerals and other useful substances sent from the Geological Section, have been included in the explanatory texts accompanying the geolgical maps, as well as in bulletins; while those of the analytical investigation and experimental tests conducted in the chemical laboratory, have been made public in special reports. The following are among the more important subjects of investigations and analyses made in this Section: domestic and foreign Portland cements; various raw materials for steel making; bricks, mortars, concretes and building stones; analyses of more than 300 specimens of magnecian and ordinary limestones; analyses of hundreds of specimens of Japanese ore, coal, coke, petroleum, etc.

MINERAL SURVEY

In 1910 a Staff for the Mineral Survey was newly organized as a department of the Imperial Geological Survey, and the work has since been carried on, first as to the mining districts of the Hokkaidō, where it is still in course of operation. The survey is being made on the scale of 1 : 50,000, 1 : 100,000 and 1 : 200,000

for the general maps, and on a scale varying from 1 : 10,000 to 1 : 30,000 for the detailed portions. The topographical and geological maps as well as the reports, prepared by the officials of the staff, are published in the Reports of the Mineral Survey. These Reports, published since 1910, are 16 in number.

STAFF OF TECHNICAL OFFICIALS

engaged in the Mineral Survey

	Geologists	Topographers	Chemists	Cartographers	Total
1910	6	6	3	5	20
1911	6	6	3	5	20
1912	6	6	3	5	20
1913	6	6	3	4	19
1914	3	3	0	2	8

APPENDIX

ON THE SURVEY OF THE HOKKAIDŌ

The earliest land-survey of the Hokkaidō was conducted by Mr. T. Inō, a well known Japanese surveyor. His work was however quite limited in extent. A further systematic survey by Lieutenant Day and others was begun in the year 1874, but unfortunately was not continued more than three years. Finally, in the year 1886, the topographical survey of the Hokkaidō was again taken up. The map of the main island or "Yesso" is divided into 32 sheet-maps or degree-rectangles like those adopted by the Imperial Geological Survey. All these sheets have been completed and are published on the scale of 1 : 200,000.

As regards the geological survey, already in 1862, the mineral resources of the Hokkaidō were investigated by Messrs. P. Blake and R. Pumpelly, American mineralogists and mining engineers in the service of the Tokugawa Government. Their attention was confined to the southern part of the principal island around Hakodate and Volcano Bay, and the results of their investigations are contained in Pumpelly's "Geological Researches in China, Mongolia and Japan" and Blake's "Reports and Official Letters to the *Kaitakushi*." After an interval of ten years, the geological survey of the Hokkaidō was resumed in the spring of 1873, the work being then carried out under the direction of Mr. B. S. Lyman till the year 1875. With the aid of many assistants, he made special surveys of its coal fields and other mineral districts, and a general exploration chiefly along the sea-board of the largest island and across the central volcanic mountain range, from the Ishikari valley to the mouth of the Tokachi river. The results

of these surveys have all been published in official reports with maps. After Mr. LYMAN had left the government service, the work was suspended for about thirteen years. But the geological survey was started again by the Hokkaidō-chō (prefectural office) in 1888, under the direction of Mr. K. JIMBŌ as Chief Geologist. The general plan was in full accordance with that adopted by the Imperial geological Survey. Mr. Jimbō and his colleagues were engaged in it from 1888 to 1896. They crossed the main island in different directions and also went as far as the northern extremity of the Chishima group, thus completing the reconnaissance survey of the Hokkaidō.

Since 1897, various parts of the Hokkaidō have occasionally been surveyed by the officials of the Imperial Geological Survey. The prospecting of the placer districts of Yūbari and Sorachi, and oil fields in the provinces of Ishikari, Iburi and Hidaka; the geological survey of the Bibai and Naie coal fields in the province of Ishikari, and the detailed agronomical survey of Obihiro-hara in the province of Tokachi have been carried out by the geologists and agronomists of the Imperial Geological Survey. At present the geological survey of the mining districts of the Hokkaidō is being systematically conducted by the officials of the Mineral Survey of the Imperial Geological Survey.

ON THE SURVEY OF TAIWAN (FORMOSA)

The geology of Taiwan received but little attention before its incorporation into the Japanese Empire. The works of Gordon, Richthofen, Guppy, Kleinwächter and others are mostly fragmentary and very imperfect. Since the establishment of Taiwan Sōtoku-fu (Japanese Administration Office of Formosa), geological Survey was commenced in the Department of Industry, under the Bureau of Civil Affairs, and Mr. S. YOKOYAMA was appointed to execute the work. At the end of the same year, Mr. Y. ISHII

was attached to the survey. In 1897, Mr. ISHII retired from his office, and Mr. K. INOUYE occupied the position of the Chief Geologist, but only for one year. Results of the geological surveys by Mr. ISHII appeared in a "Mineralogical and Geological Map of Taiwan" on the scale of 1 : 800,000 with an explanatory text (in Japanese), and in his reports found in reports of the Department of Industry; while Mr. INOUYE also wrote a report of the mineralogical and geological researches made by him. At the end of 1898, Mr. INOUYE resigned his position, and Mr. Y. SAITŌ was appointed and worked for the subsquent three years. Since the death of Mr. SAITŌ in 1901 from malaria the work of the geological survey of Taiwan has been suspended. Mr. SAITŌ, during his term of service, constructed a topographical reconnaissance map on the scale of 1 : 400,000, which was published in 1899. It includes Taiwan and its dependent islands in one sheet, and was a work preliminary to the publication of a geological reconnaissance map. The auriferous deposits of Zuihō, Kinkwaseki, and the Kiirun river, and the coal field of northern Taiwan, and the geology of the Hōko group (Pescadores) were also examined and reported by late Mr. SAITŌ. In 1905 the geological survey was recommenced under the superintendence of Mr. K. Fukutome of the Section of Mines and with the assistance of Messrs. G. Hosoya and Y. Deguchi, the last of whom had been working there for the last five years. In 1910, a geological map of the oil field of Taiwan, with an explanatory text, and in 1911 a topographical, geological and mineral map on the scale of 1 : 300,000 with explanatory text, compiled by the officials of the Section, were published. Geological surveys of the Daiton volcanic group, of the coal fields of Sanshikyaku and Hoppo, and of the Hōko group, have also been carried out and their reports have been published in the years 1911-1914.

The topographical maps (scale 1 : 20,000) published by the War Department were employed as the base of the geological

survey, together with auxiliary topographical works executed by the staff of the survey.

ON THE SURVEY OF KARAFUTO (SOUTHERN PART OF SAGHALIEN)

The geology of Karafuto was but little known to us before its re-incorporation into Japanese Empire in 1905. After the establishment of the Karafuto-chō (the Administration Office of Karafuto), a geological survey was commenced under the Bureau of Civil Affairs and Mr. S. KAWASAKI was appointed to execute the work. Prof. K. JIMBŌ of the Imperial University of Tōkyō was also engaged in the survey at the request of the Boundary Committee and the Karafuto-chō. In 1906, Mr. R. KATAYAMA was attached to the survey but retired after one year's service. The results of this survey were compiled by Mr. KAWASAKI, and a Geological Reconnaissance Map of Karafuto, on a scale of 1 : 1,000,000, accompanied by the Reports on the Survey of the Geology and Mineral Resources of Karafuto, with special reference to coal, was published first in 1907, and again in 1908 in Japanese. In 1908, three parties, consisting of Messrs. K. NISHIWADA of the Mining Bureau, Y. ŌTSUKI of the Imperial Geological Survey, and KAWASAKI, with their respective assistants, were organized to execute the survey of coal, the results being published in Japanese. In 1910, Mr. KAWASAKI, was transferred from his office to the Chōsen Sōtokufu, and the work is now suspended.

ON THE SURVEY OF CHŌSEN (COREA)

The geology of Chōsen has received much attention from geologists, but Prof. C. Gottsche was the first, who engaged in

the survey in the peninsula in 1883 and 1884, the results being published as "Geologische Skizze von Corea" with a reconnaissance map on a scale of 1 : 4,000,000. Mr. K. NISHIWADA, during the two years 1896 and 1897, in which he was in the service of the Chōsen Government, travelled through parts of northern Chōsen and his observations appeared in the Chōsen Repository in an article entitled "Useful Minerals of Korea." Mr. Y. ISHII and other geologists also made geological researches but the work was mostly fragmental. In 1901 and 1902, Prof. B. KOTŌ of the Imperial University of Tōkyō travelled twice through the peninsula and a part of the results have appeared in the Journal of the College of Science under the title "An Orographic Sketch of Korea." Mr. H. YABE made two journeys in 1903 and 1904, some of the results being published in the Journal of the College of Science. During the Russo-Japanese War five parties, under the geologists Messrs. K. INOUYE, T. IKI, and N. KANEHARA of the Imperial Geological Survey, and S. MATSUDA and H. OKADA of the Mining Bureau, were organized to carry out a reconnaissance survey of the geology and mineral resources of Chōsen, the results of which have been published in Japanese, in a series of "Reports of the Geological and Mineralogical Survey of Korea" with a geological reconnaissance map on a scale of 1 : 400,000, their compilation being undertaken by Mr. K. INOUYE in the Bulletins and the Memoirs of the Imperial Geological Survey with a general map on a scale of 1 : 1,500,000 in both Japanese and English. In 1905, the Chōsen Government founded a geological survey under the Department of Agriculture and Commerce and Mr. T. KOCHIBE was appointed as its superintendent. After the amalgamation of the Chōsen Peninsula to the Japanese Empire Mr. Kochibe retired from the service. The geological survey was then transferred to the Japanese Government of Chōsen (Chōsen Sōtokufu), and placed under the superintendence of Mr. S. Murata of the Section of Mines, Mr. S. Kawasaki being in charge of the survey, with two

other geologists, Messrs. S. Nakamura and E. Tamura. The result of this geological survey appears in Reports and Bulletins of which 4 Reports and 1 Bulletin, have been published.

ON THE SURVEY OF SOUTHERN MANCHURIA

The geological investigation of China is indeed of the utmost interest to science and consequently the geologists from all parts of the world have oftentimes visited the country. As to southern Manchuria almost all the literature is scattered through many and diverse publications, except Baron Prof. v. Richthofen's bulky work. During the Sino-Japanese War Messrs. T. Kochibe and T. Suzuki of the Imperial Geological Survey and Prof. K. Jimbō of the Imperial University travelled through the southern part of Manchuria, their results being published in Japanese in 1895 and 1898. During the Russo-Japanese War Messrs. T. Ogawa, N. Kanehara, Y. Ōtsuki, and Y. Ōinouye of the Imperial Geological Survey, S. Kawasaki and N. Abe of the Mining Bureau, N. Fukuchi of the Imperial University and O. Yoshida were sent to southern Manchuria for a survey of the geology and mineral resources of that country. Their results were published in the succeeding years in Japanese with a geological reconnaissance map on a scale of 1 : 400,000. A part of this work has been reported by Messrs. T. Ogawa and K. Inouye in the Bulletins of the Imperial Geological Survey with a geological map on a scale of 1 : 1,000,000, both in Japanese and English. Since the establishment of the Kwantō-totoku-fu (the Administration Office of Kwantō-shū) Mr. O. Yoshida has been attached to the survey. Mr. C. Kido, geologist of the South-Manchurian Railway Company, is now engaging in carrying out a geological survey along the railway. The mineral localities of southern Manchuria and the report on the mineral survey of the neutral territory by Mr. O. Yoshida were published in 1913.

The South-Manchurian Railway Company at the same time organized a Geological Institute to carry out the geological survey along the railway. Mr. C. Kido, the superintendent of this Institute, is now engaged in the geological survey of the district with two other geologists, Messrs. H. Murakami and J. Sakakura. The reports appear in the Journal of the Mining Industry of China of which 25 numbers have been published by the Institute.

RESULTS OF THE GEOLOGICAL SURVEY

As already stated, the reconnaissance geological survey was completed in 1894, and the geological survey, which is on a scale of 1 : 200,000, is now almost complete, eighty-nine sheets out of ninety-eight having already been published. Professors of the Imperial University and some other geologists have also investigated various problems of our geology. From their results, we give here an epitome of the outlines of the general geology of the Japanese Empire together with a short sketch of the copper mines of Japan.

GENERAL GEOLOGY

The lowest stratified rocks composing the Japanese Empire are the Gneiss and Crystalline Schist Systems of the Archæan Group. Then follows the Palæozoic formation, in which the earliest fossiliferous rocks are found. The Mesozoic formations were next deposited. During the sedimentation of the Palæozoic and the Mesozoic rocks, intrusions of granite, diorite, gabbro, porphyrite, etc., occurred. During the Cainozoic era, especially in the Tertiary times, sediments of volcanic ejectamenta formed the various kinds of tuffs. These are most widely distributed in northen Japan and the Hokkaido. Volcanic rocks erupted in different places.

ARCHÆAN GROUP

1. Gneiss System

The Gneiss System consists of biotite-gneiss, hornblende-gneiss, granite-gneiss, mica-schist and amphibolite, frequently intercalated with saccharoidal limestone and granulite. Two-mica-gneiss and pyroxene-gneiss are known in Chōsen and in southern Manchuria. Various kinds of gneiss show in several cases the characters of metamorphic eruptive rocks; while the mica-schists, amphibolites, and limestone seem oftentimes to have been derived from sedimentaries, metamorphosed by the contact action of the eruptive rocks. Granites frequently intrude them in a confused manner, and these granites are treated in many cases as belonging to the Gneiss. Also schistose granite, by the protrusion of which the Palæozoic rocks were changed to gneisses and schists, is also often included in the Gneiss together with the sedimentaries.

2. Crystalline Schist System

The Crystalline Schist System consists of various schists of a phyllitic aspect with the characteristic components of sericite, chlorite, epidote, and calcite. They are epidote-gneiss, graphite-gneiss, sericite-gneiss, graphite-schist, chlorite-schist, sericite-schist, piedmontite-schist, quartz-schist, chlorite-amphibolite, and limestone, often accompanied with eruptives, such as serpentine and gabbro, but not by granitic eruptives. Glaucophane-schist is known only in Shikoku and Kyūshū, and in the province of Kii, but not in central Honshū. Crystalline schist is clearly distinguished from all varieties of gneiss, except amphibolites; but the distinction from the lowest series of the Palæozoic, consisting of amphibolites, pyroxenites and phyllites, is not always clearly made, and is often very confusing.

PALÆOZOIC GROUP

The Palæozoic of Japan consists of a series of formations of enormous thickness, which may, by the order of superposition and lithological character, be divided into the Lower, the Middle and the Upper Formations. The Upper Carboniferous or Permo-carboniferous fauna of stratigraphical importance are only found in narrow zones in the Middle and Upper Formations. The Lower Palæozoic is composed of metamorphic rocks, consisting mainly of pyroxenites with subordinate layers of amphibolites and phyllites, and is often accompanied with serpentine and gabbro. Crystalline limestone and quartzite often interstratify with the pyroxenite. The Middle and Upper Palæozoic consist of schalstein sandstone, clayslate, quartzite, hornstone, limestone, radiolarian slate, adinole slate, etc., and commonly rest conformably on the Lower Palæozoic. Among these rocks, crumpled quartzite and hornstone of various colors, adinole slate, schalstein with limestone, radiolarian slate, and *Fusulina* and crinoidal limestones, are easily recognizable and indeed the marks of the correlation. Among the fossils, *Fusulina* and *Schwagerina* are most common, genera *Climacammina*, *Lingulina*, *Textularia*, *Tetrataxis*, *Endothyra*, *Cyathophyllum*, *Favosites*, *Poteriocrinus*, *Pentacrinus*, *Archæocidaris*, *Serpula*, *Fenestella*, *Rhynchonella*, *Lyttonia*, *Spirifer*, *Bellerophon*, *Pleurotomaria*, and some other indeterminable forms and casts of Trilobites, Bryozoans, Brachiopods, Corals, Crinoids, etc., are also found in the formations. A specimen of *Hericoprion* has been found in the crinoidal limestone in the province of Kōzuke.

In Chōsen, the lower series of the Palæozoic consists of rather metamorphic rocks, composed in descending order mainly of, 1). limestone intercalating clayslate and sandstone, 2). biotite schist, clayslate and sandstone, 3). quartzite. Limestone in various parts of the country contains fossils, such as Trilobites, Brachiopods, Actinocrinus, Maclurea, Raphistoma, etc., which tend to prove

that the formation belongs to the Cambro-ordovician. The formation occupies a wide area in the northern part, besides small scattered areas. The upper formation consists mainly of limestone with clayslate and hornstone, and clayslate and sandstone intercalating anthracite seams. The formation imbeds fossil fauna, such as Schwagerina, Fusulina, Stacheia, Bigenerina, Lagena, Corals, Crinoids, Brachiopods, Gasteropods, etc., and fossil flora, such as Lepidodendron, Calamites, Tæniopteris, Pecopteris, Annuraria, etc., by which the formation has been proved to belong to the Permo-carboniferous. It occupies a large area in the southern part, besides small scattered areas.

In southern Manchuria, the Palæozoic is divisible into the Cambro-silurian and Carboniferous Systems. The lower series of the Cambro-silurian, that is, the Ta-ku-shan Series, consists mainly of quartzite with subordinate layers of quartzose sandstone and clayslate, sometimes conglomerate and limestone. The upper formation, that is, the Sinian Formation, consists mainly of an alternation of sandstone and clayslate with subordinate layers of conglomerate and limestone in the lower, and of limestone and marl with sandstone, clayslate and quartzite in the upper part. Limestone of the various horizons contains fossils, such as *Coscinocyathus*, *Lingulella*, *Acrotreta*, *Linnarssonia*, *Orthis*, *Salterella*, *Theca*, *Hyolithes*, *Orthoceras*, *Agnostus*, *Olenoides*, *Ptychoparia*, *Conocephalites*, *Anomocare*, *Liostracus*, *Arthricocephalus*, etc. The Carboniferous is found only in small patches, as in Pên-hsi-hu, Y'en-tai, Wu-hu-tsui, Cha-tsu-yao, of F'u-chou, where coal-seams are imbedded in the strata. The lower formation of the Carboniferous consists of an alternation of limestone and marl, in which fossils of Corals, Crinoids, Brachiopods, Echinoids, Gasteropods, etc. are imbedded. Among these fossils, *Cyanthophyllum*, *Syringopora*, *Chætetes*, *Archæocidaris*, *Streptorhynchus* have been determined. The upper formation or Coal Measures consist mainly of sandstone and clayslate with coal-seams. The genera *Neuropteris*, *Tæniopteris*, *Cyathaites*, *Lepido-*

dendron, *Lepidophyllum*, *Cordaites*, *Samaropsis*, *Pterophyllum*, *Callipteridium*, *Annularia*, etc. are found in the strata.

MESOZOIC GROUP

The Mesozoic is limited in its extension, as compared with the Palæozoic. It is divided into three divisions.

1. Triassic System

The Triassic System occupies small areas, and consists mainly of sandstone and clayslate, or shale, sometimes intercalating tuff, limestone and also anthracite. The Triassic of Kitakami, in the province of Rikuchū, of Sakawa in the province of Tosa, and of Kuriki in the province of Higo, yields marine fauna, such as *Ceratites* and *Pseudomonotis*, which are considered closely allied to those of the Californian Trias. Besides, *Danubites*, *Arpadites*, *Anorcites*, *Daonella*, *Terebratula*, *Avicula*, *Pecten*, *Lima*, *Exogyra*, stems of Crinoids, etc., are also found. The Trias of Yamanoi, in the province of Nagato, yields Rhætic flora, such as *Cladophlebis*, *Dictyophyllum*, *Podozamites*, *Nilssonia*, *Baiera*, etc., and in Nariwa, in the province of Bitchū, *Cladophlebis*, *Sagenopteris*, *Arthrophyopsis* (?), *Nilssonia*, *Podozamites* are found, which seem to be comparable to the Rhætic of Nagato. At the south of Nariwa, *Pseudomonotis* is also found.

In Chōsen, the Triassic occurs in two small areas, the one along the Tai-dong-gang in South Phyöng-an-do and the other near Mun-gyong in North Kyöng-syang-do. It consists of clayslate and sandstone, which imbed *Gigantopteris*, *Clathropteris* (?), *Annuroids*, etc.

2. Jurassic System

The Jurassic of Japan is in small detached areas, consisting of clayslate or shale, sandstone and conglomerate; schalstein,

crystalline limestone and also anthracite are found in the Jurassic of Nagato. The schalstein, which is widely distributed in Chūgoku and northern Kyūshū mapped as the Mesozoic of an unknown epoch, resembles the Liassic schalstein of Nagato. The Jurassic of Nagato, Rikuzen, and Echizen contains marine fauna, such as *Hildoceras*, *Grammoceras;? Harpoceras*, *Cœloceras*, *Dactylioceras*, etc. in Nagato; *Harpoceras*, *Schlotheimia*, *Lytoceras*, *Trigonia*, *Belemnites*, *Cyrena*, *Gervillia*, *Perna*, etc. in Rikuzen; and *Perisphinctes*, *Oppelia*, etc. in Echizen. The Jurassic in Echizen, Etchū, Echigo, Kaga, Mino, and Hida consists of brackish-water deposits with plant fossils, such as *Thyrsopteris*, *Dicksonia*, *Onychyopsis*, *Adiantites*, *Asplenium*, *Sphenopteris*, *Pecopteris*, *Macrotæniopteris*, *Sagenopteris*, *Equisetum*, *Anomozamites*, *Nilssonia*, *Dioonites*, *Zamites*, *Podozamites*, *Dictyozamites*, *Cycadeospermum*, *Gingkodium*, *Gingko*, *Czekanowskia*, *Taxites*, *Pinus*, *Palissya*, *Vallisnerites*, and *Carpolithes*. The lower horizon of it often contains fresh-water shells, *Cyrena* forming an important part, with sometimes *Ostracoda*, *Apiocrinus;* and in Echizen, Ammonites, etc.

In Chōsen, the Jurassic develops at the southeast, and consists of sandstone, conglomerate, clayslate, schalstein, limestone and hornstone. Plant fossils, such as *Dictyozamites*, *Nilssonia*, *Podozamites*, *Pinus*, *Onychiopsis*, *Coniopteris*, *Cladophlebis*, *Sphenopteris*, *Adiantites*, *Sagenopteris*, *Equisetum*, etc. are imbedded in it. Other small patches of the Jurassic consist mainly of sandstone, conglomerate and clayslate, with places having schalstein and limestone, the plant fossils, such as *Podozamites* and *Todites*, being found only near Phyöng-yang.

In southern Manchuria, the Jurassic consists of sandstone, conglomerate and clayslate with coal-seams, and yields plant fossils, such as *Todites*, *Baiera*, *Ctenis*, *Czekanowskia*, *Gingko*, etc.

3. Cretaceous System

The Cretaceous System has the widest distribution of all

the Mesozoic, and is rich in fauna and flora. The lower Cretaceous, which has been developed on the Pacific side of Honshū and Shikoku, consists of series of shale and sandstone with the so-called Torinosu limestone. The limestone contains abundant fauna, consisting of Foraminifera, Corals, Bryozoa, Echinoids, Bivalves and Gasteropods. The Cretaceous in the provinces of Rikuzen, Iwaki, Kōzuke, Kii, Awa, and Tosa, consists of conglomerate, sandstone and shale. Generally, a *Cyrena* bed occurs in the lower horizon, a plant bed a little higher, and a *Trigonia* sandstone in the uppermost. The plant fossils are *Thyrsopteris*, *Asplenium*, *Dicksonia*, *Dicksoniopteris*, *Onychiopsis*, *Adiantites*, *Sphenopteris*, *Pecopteris*, *Cladophlebis*, *Licopodites*, *Podozamites*, *Zamiophyllum*, *Glossozamites*, *Nilssonia*, *Ptilophyllum*, *Torreya*, etc. The Cretaceous, forming a long chain from the boundary between the provinces of Izumi and Kii to Amakusa through the provinces of Awaji, Sanuki, Iyo and Bungo, consists chiefly of sandstone and shale with conglomerate, and contains marine fauna, such as *Pravitoceras*, *Anisoceras*, *Peroniceras*, *Lytoceras*, *Phylloceras*, *Hamites*, *Helicoceras*, *Inoceramus*, *Belemnites*, *Cucullæa*, *Avicula*, *Capulus*, *Crassatella*, *Aletryonia*, *Trigonia*, etc., and some plant fossils. In southern Shikoku it consists of sandstone and shale with conglomerate and limestone, *Inoceramus* being discovered in the strata. The Cretaceous of the Hokkaidō, consisting of shale, sandstone and conglomerate, yields abundant forms of Ammonites, besides, *Plesiosaurus*, *Lamna*, *Eucorystes*, *Ananchytinarum*, *Pentacrinus*, *Margarita*, *Helcion*, *Exogyra*, *Pecten*, *Inceramus*, *Trigonia*, *Pectunculus*, *Nucula*, *Cucullæa*, *Lucina*, *Meekea*, *Thetis*, *Solen*, *Siliqua*, *Rhynchonella*, *Kingena*, *Carysphyllia*, *Orbitolina* etc. The Ammonites are *Lytoceras*, *Gaudryceras*, *Tetragonites*, *Turrilites*, *Helioceras*, *Heteroceras*, *Nipponites*, *Olcostephanus*, *Desmoceras*, *Hauericeras*, etc. The Mesozoic of Karafuto consists of shale, sandstone, conglomerate and marl, abundant fauna, such as Ammonites, *Helcion*, *Inoceramus*, etc. being imbedded in the strata.

4. Doubtful Mesozoic

The Mesozoic consists mainly of shale and sandstone, sometimes with impure limestone. In the Mesozoic of southern Kyūshū, *Inoceramus* and Torinosu limestone were recently discovered. The Mesozoic of Taiwan consists mainly of clay-slate with sandstone.

CAINOZOIC GROUP

1. Tertiary System

The Tertiary consists of sand, gravel, clay, tuff, sandstone, conglomerate and shale, with intervening layers of limestone, marl, coal-seams and diatom-earth. As the result of volcanic activity, tuffs are very widely prevalent, sandstone and shale attaining very frequently a tufaceous character. The comparative study of fossils, which are very abundant, is still very imperfect; but Pliocene and Miocene beds have been recognized, the former chiefly by shell remains and the latter by plants and a few Foraminifera, though the definite boundary between them has not yet been traced except in a few cases. The Eocene is only known in Ogasawarajima, where the tuff yields *Nummulites*.* The various kinds of Gasteropoda, Solenochonchæ, Conchifera, Brachiopoda, Echinoidea, Asteroidea, Foraminifera, etc. are abundantly found in the Tertiary, and those found in the Pliocene belong mostly to species now living in the Japanese and Chinese seas, only a few being extinct in the neighboring seas. Sometimes the bones and teeth of such mammals

* *Nummulite* has also been discovered in Okinawa island, and in the limestone of Nakakosaka in the province of Kōzuke, with orbitoides. Though the stratigraphical relation has not yet been studied, it is highly possible that there exists a horizon which represents a Miocene-eocene period. Whether the Miike coal field, where *Alveria ziczac* has been discovered, belongs to the Eocene or not, is now under discussion.

as *Elephas*, *Stegodon*, *Ursus*, *Cervus*, *Bison*, *Rhinoceras*, *Delphinus*, *Sus*, *Equus*, and whale, and rarely insects are found in the post-Miocene and Pliocene; while shark's teeth specified as *Carcharodon megalodon* Ag., are found in the probably Miocene strata in several parts of Japan. The fossil flora, which are found most frequently in the pre-Pliocene or Miocene strata, are *Taxodium*, *Equisetum*, *Pinus*, *Torreya*, *Cephalolaxus*, *Abies*, *Sequoia*, *Vitis*, *Vitiphyllum*, *Acer*, *Platanus*, *Alnus*, *Betula*, *Carpinus*, *Carpiniphyllum*, *Quercus*, *Querciphyllum*, *Fagus*, *Fagophyllum*, *Castanea*, *Juglans*, *Comptonia*, *Comptoniphyllum*, *Salix*, *Populus*, *Planera*, *Ulmus*, *Ficus*, *Cinnamomum*, *Lauriphyllum*, *Aesculus*, *Aesculiphyllum*, *Cercidiphyllum*, *Tilia*, *Sapindophyllum*, *Liquidambar*, *Zizyphus*, *Trapa*, *Pterocarpa*, *Diospyros*, *Phyllites*, etc. The forms very often found in the Pliocene are: *Taxodium*, *Pinus*, *Cyperus*, *Cyperites*, *Bambusa*, *Vitis*, *Acer*, *Alnus*, *Haveniphyllum*, *Betula*, *Corylus*, *Ostrya*, *Carpinus*, *Quercus*, *Fagus*, *Castanea*, *Juglans*, *Salix*, *Populus*, *Zelkova*, *Ulmus*, *Aphanante*, *Lindera*, *Cinnamomum*, *Clematis*, *Cercidiphyllum*, *Elaeocarpus*, *Tilia*, *Zanthoxylon*, *Dictamnus*, *Rhus*, *Meliosma*, *Viburnum*, *Liquidambar*, *Ilex*, *Rhamnus*, *Zizyphus*, *Celtis*, *Exocoecaria*, *Araliphyllum*, *Acanthopanax*, *Cornus*, *Deutzia*, *Styrax*, *Cydonia*, *Sorbus*, *Prunus*, *Sophora*, *Leguminosites*, *Vaccinium*, *Tripetalja*, *Diospyros*, *Polygonum*, *Phyllites*, *Magnolia*, *Stuartia*, *Clethra*, *Myliophyllum*, etc. The fossil flora of the Miocene and the Pliocene are mostly common in genera but different in their species. Among the pre-Pliocene or Miocene flora, both European and Arctic elements are found; while most of the Pliocene flora are very intimately related to species now living especially in the mountain regions of Japan and some to those now met with in other parts of the world. From these facts together with the evidence of fossil fauna it is considered that the Pliocene Period had a colder climate than that now prevailing in those regions.

2. Quaternary

Diluvium

The Diluvium consists of sand, gravel, clay, and pumice, often covered with a fine deposit of vocanic nature, and forms low undulatory plateaus or elevated platforms as well as terraces.

Alluvium

The Alluvium consists of fluviatile deposits of sand, gravel, and clay, as well as the sands of beaches and dunes.

3. Elevated Coral Reef

Elevated coral reef is only found in Taiwan and Ryūkyū along the beach, or inland, forming the plateau.

IGNEOUS ROCKS

Granite

Granites are of hornblende-granite, granitite, and hornblende-granitite, being the most widely extended of all the plutonic rocks. A part of the schistose granite and also those parts which intrude the Palæozoic in a confused manner, are often included in the Gneiss System together with the Palæozoic. Contact phenomena of granite on sedimentaries have been observed in several places, cordierite, sometimes andalusite being found in the Palæozoic clayslate as well as in the Mesozoic, in the provinces of Hitaka, Rikuchū, Shimotsuke, Wakasa, Yamashiro, Tanba, and garnet, vesuvianite and wollastonite in limestones, in the provinces of Uzen, Ōmi, Buzen, etc.

Porphyry

Porphyry occurs forming large masses in the inner zone,

especially of South Japan, but mostly as small dykes throughout the country. The rocks are chiefly of quartz-porphyry and often approach granite in composition on one side, known as granite-porphyry, and liparite on the other.

Diorite

Diorite is generally quartz-diorite. The age of eruption is often uncertain. Structurally it is considered to be one of the older eruptives, but one mass in the province of Sagami intrudes the Tertiary. Gabbro-diorite occurs in small areas, often accompanied by gabbro.

Gabbro, Peridotite, Serpentine, etc.

Gabbro, Peridotite, Serpentine etc. often occur together. The gabbro and serpentine are mainly found in crystalline schist and the Palæozoic formation, but those in Chūgoku seem to belong to a later issue.

Diabase

Diabase is found intercalated in the Palæozoic as well as in the Mesozoic, and accompanied with the variegated schalstein, showing a mighty eruption of it in the Palæozoic, and the Mesozoic eras.

Porphyrite

Porphyrite occurs in tolerable areas at several places; but generally, it is found as dykes or sheets in the Palæozoic as well as in the Mesozoic, while some seem to be of a later eruption, intruding the Tertiary.

Liparite

Liparite is of various kinds, their tuffs developing widely

with thick sediments especially in North Japan, resulting from the eruptions probably from the beginning of the Tertiary period. Besides, the liparite occurs as dykes in several places, intruding the Tertiary as well as the older formations.

Trachyte

Trachyte occupies only small areas in the province of Oki. It occurs in dykes, intruding the volcanic rocks, and also in flow and sheet form.

Andesite

Andesites, including dacite, mica-hornblende-andesite, pyroxene-andesite, and olivine-pyroxene-andesite, have the widest distribution of all the igneous rocks. Among them, pyroxene-andesite and olivine-pyroxene-andesite are the most widely distributed and forms the huge volcanoes, especially of North Japan, and Kyūshū, such as Fuji, Asama, Nasu, Zaō, Chōkai, Iwate, Iwaki, Aso, Kirishima, etc. Mica-hornblende-andesite seems to be the next in distribution, and constitutes main volcanoes in South Japan, especially along the coast of the Sea of Japan, as Norikura, Hakusan, Daisen, Sambe, Unzen, Kujū, etc. Dacite is limited in distribution, being found especially in the northern part of Honshū. Rhombic-pyroxene-andesite, which may easily be distinguished from other kinds of andesites in texture, forms a volcanic series of small simple cones along the Inland Sea, as Kabutoyama in the province of Settsu, Iinoyama in Sanuki, Kofuji in Iyo, etc. The andesite has been erupted extensively since the Tertiary period, being in most cases accompanied with tuff, agglomerate-tuff, lava-breccia, etc. Some andesites are also frequently found as sheets and dykes. The volcanoes of Japan are mostly composed of andesite, being 165 in number, among which 63 active ones are enumerated. They are simple-coned, as Fuji, Kaimon, etc., double-coned as Asama, Sambe,

etc., or more complex as Aso, Hakone, etc. Also the crater lakes, such as Osorezan Lake in Osorezan, Zaōnuma in Zaōsan, Ōnamiike in Kirishima, etc., are to be mentioned.

Basalt

Basalt outcrops rather in small areas in Chūgoku and northern Kyūshū, forming plateaus and sometimes simple domes or cones, such as Kasayama in the province of Nagato, and Kannabeyama in Harima, etc., and also occurs often as intrusive sheets and dykes in these regions.

Volcanic Ashes and Mud Lava

Mud lava always forms plateaus. It occupies wide areas in Kyūshū, where it is considered to have been erupted from the volcanoes Aso and Kirishima. It is also widely found along the slopes of the volcanoes, but not so conspicuously as on Aso and Kirishima. Volcanic Ashes are widely distributed especially along the slopes of volcanoes, covering the mud lava, or sometimes alternating with it, as in Kyūshū.

COPPER MINES OF JAPAN

The production of copper in 1913 was 148,139,887 pounds. The mines, which yielded above 500,000 pounds in the same year, were thirty-seven in number, as shown in the map of the Principal Copper Mines of the Japanese Empire, while of those above 1,500,000 pounds there were twenty-one, the specimens of which were arranged in the show case of Copper Ores of the Principal Copper Mines (showing the structures).

The copper production of the last five years is as follows:

1909 . .	102,036,495 lbs.	1912 . .	140,891,021 lbs.
1910 . .	109,747,626 ,,	1913 . .	148,139,887 ,,
1911 . .	119,868,686 ,,		

The copper mines, which yielded above 500,000 pounds in 1913, are as follows :

Name of Mines.	*Provinces.*	*Products.* lbs	*Name of Mines.*	*Provinces.*	*Products.*
Ashio	Shimotsuke	23,006,515	Hanaoka	Ugo	1,664,650
Hitachi	Hitachi	21,620,497	Yaguki	Iwaki	1,585,069
Besshi and Nishinokawa	Iyo	16,852,380	Yoshioka	Bitchū	1,520,058
Kosaka	Rikuchū	14,906,498	Ōse	Iyo	1,382,182
Kune	Tōtōmi	9,565,297	Nagamatsu	Uzen	1,313,795
Osaruzawa and Komagi	Ugo	4,619,896	Ōkura	,,	1,280,806
Ikuno	Tajima	4,015,317	Furokura	Rikuchū	1,211,763
Abeshiro	Mutsu	3,451,741	Hōmanzan	Izumo	942,557
Kinkwaseki	Taiwan	3,406,568	Ōmori	Iwami	904,215
Ogoya	Kaga	3,169,766	Kidogasawa	Shimotsuke	775,004
Ani	Ugo	2,515,871	Mizusawa	Rikuchū	773,218
Kamaishi	Rikuchū	2,502,309	Sasagatani	Iwami	707,257
Arakawa	Ugo	2,366,097	Mochikura	Echigo	673,035
Kunitomi	Shiribeshi	2,156,318	Ōtori	Uzen	645,570
Hisaichi	Ugo	1,865,107	Chūshiro	Iyo	616,859
Hibira	Hyūga	1,858,380	Ōmine	,,	613,388
Obie	Bitchū	1,810,279	Kanō	Iwashiro	592,901
Makimine	Hyūga	1,789,487	Omodani	Echizen	590,712
Yūsenji	Kaga	1,770,452	Hiragane	Hida	584,802
			Ōarasawa	Rikuchū	580,218

The chief sources of copper are acid ores, basic ores and 'Kuromono.'

The copper ores are the most widely distributed of the metallic minerals. They occur in rock of a wide range from the Crystalline Schist System to the Tertiary, and are also found in the igneous rocks. The basic ores, consisting of intimate mixtures of chalcopyrite and iron pyrites, are mostly confined to the outer zone, especially to that of South Japan. They occur in the Crystalline Schist and in the Palæozoic and follow generally the plane of stratification ; they have long been known as the bedded deposits. Their chief productive sources are in the Crystalline Schist especially in Shikoku, the Besshi mine being their representative. The Kune mine is isolated in central Japan, its ores being chiefly transported for smelting to the other mines. The Hitachi mine is the only deposit found in the Schist in the North Japan. The Palæozoic is much less

productive, though the famous Hibira and Makimine mines lie in it. Basic ores are also found in the Mesozoic, especially in the provinces of Yamato, Kii and Tosa, but are not sufficiently important to be mentioned in detail. The acid ores are widely distributed in the inner zone especially in Northeast Japan and Chūgoku, and their mode of occurrence seems to differ in different places. In Northeast Japan and also in the provinces of Echizen and Kaga, they occur mostly as veins in the Tertiary, liparite, propylite and andesite, or near their contact, the deposits in the Osaruzawa, Ani, Arakawa, Hisaichi, Nagamatsu, Ogoya and Yūsenji mines being well known, while some deposits are found in the Mesozoic and quartz-porphyry, and in the granite near its contact with the liparite. The vein-stuff is almost always quartz, accompanied with calcite and barite, except in a few cases. The ores are chalcopyrite, iron pyrites and zinc blende being almost always present often with bornite and galena. The copper veins of the famous Ashio mine are chiefly found in the liparite, the Palæozoic in the peripheral part of the district also carrying veins, though they are not important. In central Japan, as in the province of Hida, the copper deposits are found in the Palæozoic and generally follow the plane of stratification, being considered to be the bedded veins. The ores are chalcopyrite with pyrite and zinc blende. In Chūgoku excepting the deposits of the Ikuno and some other mines, they are mostly found as veins in the Palæozoic as well as in the Tertiary, accompanied by igneous rocks, some being considered as contact deposits. The most important deposits occur in the Palæozoic with igneous rocks ; i.e., near the contact with granite, as in the Obie mine, with quartz-porphyry and porphyrite, as in the Yoshioka mine. The vein-stuff is quartz, often accompanied with contact minerals. The ores are chalcopyrite, accompanied with pyrrhotite, and pyrite with galena and zinc blende. The deposits of the Ikuno mine are found in the Tertiary tuff as well as in liparite and propylite

as veins, carrying pyrite, chalcopyrite, argentite, galena, etc. often with quartz and calcite. The deposits of the Kamaishi and Yaguki mines are known to occur in the Palæozoic limestone and clayslate along or near the contact with granite and diorite. The ores are rather basic, consisting of pyrite, chalcopyrite, pyrrhotite, magnetite, etc. with contact minerals, such as pyroxene, garnet, epidote, quartz, etc. 'Kuromono' consists mainly of intimate admixtures of zinc blende, galena and barite, with chalcopyrite and pyrite, containing gold and silver. Its colour is not always black, being sometimes dark gray, yellow or white, etc., according to the proportion of the constituent minerals. When the ore is rich in silica, thus containing much quartz, it is rather white or pale gray in colour, and is called 'Keikō' or silicious ore, while that containing much pyrite is yellowish, and is commonly known as 'Ōkō' or yellow ore. Thus the ratio of production of several metals differs largely in different mines. It is practically confined to the inner zone of Northeast Japan and the Hokkaidō, as in the Kosaka, Abeshiro, Kunitomi and Hanaoka mines, and occurs in the Tertiary accompanied with liparite, dacite, propylite, and andesite. It forms large irregular masses, often attaining a thickness of several hundred feet, as in the Kosaka mine. The mode of occurrence has not yet been thoroughly investigated, but suggests that it belongs to the metasomatic deposits.

A

CATALOGUE OF ARTICLES

EXHIBITED BY THE

IMPERIAL GEOLOGICAL SURVEY

OF

JAPAN

AT THE

PANAMA-PACIFIC INTERNATIONAL EXPOSITION

HELD AT

SAN FRANCISCO, UNITED STATES OF AMERICA

1915

A

CATALOGUE OF EXHIBITS

(1) MAPS

Topographical and geological maps (Scale 1: 400,000):

Division III.

Special topographical and geological maps (Scale 1: 200,000):

Section Ichinohe,
„ Kiso,
„ Hiroshima,
„ Kaseda.

Geological map of the Japanese Empire (Scale 1: 2,000,000).
Distribution of Volcanoes in Kyūshū (Scale 1: 400,000).
Geological map of the volcano Aso (Scale 1: 100,000).
Geological map of the volcano Sakurajima (Scale 1: 20,000).
Principal copper mines of the Japanese Empire (Scale 1: 2,000,000).
Mineral Maps (Scale 1: 400,000):

Division III,
Division IV.

Geological map of the Japanese Empire (Scale 1: 2,000,000).
Mineral distribution of the Japanese Empire (Scale 1: 2,000,000).
Detailed geological map (Scale 1: 10,000):
Jōban coal field. Section I.

(2) RELIEFS

Relief of the Volcano Aso, Province Higo (Horizontal scale 1 : 50,000 ; vertical scale 1 : 25,000).
E-W Section across the Volcano Aso.
Photographs of the craters of the Volcano Aso.

Aso is a grand active volcano situated in the central part of Kyūshū. Its base covers an area, of about 2,600 square miles, extending into the two provinces of Higo and Bungo. It has a vast old crater, about 15 miles in length and 10 miles in width, nearly elliptical in shape and surrounded with cliffs from 1,000 to 2,600 feet high. This crater is believed to have been formed by depression after an enormous outflow of so-called Mud-lava. Several central cones rise within the crater, regularly arranged in two linear directions, N-S and E-W, cross ch other. Nekodake, Takadake and Eboshidake stand on the E-W line; and Ōjōdake, Kishimadake, Eboshidake and Okamado are on the N-S line. Although each cone has one or more craters, Nakadake is now the only active centre. At the summit of Nakadake, there are four craters, separated by low walls of ashes and cinder, and arranged in the north-south direction. They are almost circular in shape and hold lakelets. Crater number 1 which had been evidently active for some time, issuing smoke and ashes, and sometimes even lava blocks, is now quite inactive and holds a lakelet of warm water. In the southern wall of crater number 2 near the bottom, there is an orifice through which vapours escape.

The volcanoes Kibōsan and Kujūsan are situated on the western and northeastern sides respectively of the volcano Aso. The former is extinct, while the latter active.

Reliefs of the Volcano Sakurajima, before and after the eruption 1914.

Horizontal and vertical scale { 1 : 20,000 before the eruption / 1 : 10,000 after the eruption

N-S and E-W sections across the Volcano Sakurajima.
Sakurajima is an active volcanic island, situated in the Bay

of Kagoshima. It is famous for great eruptions in earlier days, especially in the year 1779. Near the center of the island there are two high peaks, Minamidake and Kitadake, and the slightly depressed part between them is called Nakadake. These three peaks run nearly in the north-south direction. On the southeastern flank of the island, there is the flat lateral cone of Nabeyama, while on the west, the dome of Hikinohira is very conspicuous. The rocky protuberances of Moezaki on the southwestern and of Ōmoezaki on the northeastern side of the island were formed by the lava flows of the years 1471-1476, while the eruption of the year 1779 was followed by an enormous lava flow, which formed the promontories of Nishisakohana on the northeastern side, and in the vicinity of Tatsuzaki. The isle of Niijima and other smaller ones, situated to the northeast of Sakurajima, are the results of the submarine activity which followed the eruption of the year 1779, and the small isles of Karasujima to the west (now entirely buried under lava) and Okojima off cape Moezaki, its southwestern corner, are believed to be the remnant hill blocks of the main island of Kyūshū, remaining in the form of a "horst". In January 1914, a great eruption took place. It may be counted as one of the greatest volcanic catastrophes in modern times. About four principal craterlets were formed at the western, and three at the eastern side, of the island. An enormous quantity of lava issued out from these craterlets, reaching the shore, and even extending under the sea. In the west, i.e., in the channel of Kagoshima, the lava flow entirely buried the small isle of Karasujima, its extension into the sea being roughly 1,700 meters, while on the east or Nabeyama side it blocked up the strait of Seto, whose width was about 500 meters. On the 29th of the same month, it bulged up into hills, 50 meters or more in vertical height, and flowed some 2,000 meters under the sea. The hamlets of Yokoyama and Akamizu on the western shore of the island, and that of Seto and the Arimura hot spring with its bath-houses on the southeastern shore, were completely buried beneath the descending torrents of lava. The hamlet of Kurokami on the eastern shore of the island, together with its hot-spring bath-houses, was entirely destroyed by ejecta-

menta, and buried beneath a layer of pumiceous lapilli and ashes more than six feet deep. The craterlets on the western flank have now ceased to emit molten lava and scoriæ, and even to discharge steam and sulphurous vapours, but two or three craterlets on the eastern slope, or in Nabeyama side, are still active, emitting lava blocks, lapilli and scoriæ together with ashes and vapours.

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(3) PHOTOGRAPHS

Volcano Sakurajima, Prov. Satsuma after the eruption of 1914.
- General view, seen from Sakkabira (Sept. 1914).
- Lava flowing down toward the Sea, seen from the city of Kagoshima (Jan. 1914).
- Village Kurokami, buried under the Volcanic Ashes (Jan. 1914).

Volcano Aso, Prov. Higo.
- Craters of Nakadake (active).
- Craters Nos. 1 and 2 Nakadake.
- Crater No. 3 of Nakadake.

Volcano Tarumaeyama, Prov. Iburi.
- Dome formed in 1909, seen from the South.

Volcano Kujūsan, Prov. Bungo.
- Crater-lake.

Volcano Kirishimayama, Prov. Ōsumi.
- Mud-cones.

Volcano Kaimondake, Prov. Satsuma.
- General View, seen from the East.

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(4) EXPLANATORY TEXTS, BULLETINS, REPORTS, ETC.

Explanatory texts to the special geological maps, together with the

special topographical and geological maps,
Section Aomori,
„ Ichinohe,
„ Murakami,
„ Kanazawa,
„ Wakayama,
„ Hiroshima,
„ Matsuyama,
„ Nagasaki,
„ Fukae,
„ Kaseda.

Explanatory text to the detailed geological map,
Jōban Coal Field (in Japanese with English resumé).

Bulletins of the Imperial Geological Survey of Japan,
Vols. XXI-XXIV (in Japanese with English resumé).

Reports of the Imperial Geological Survey of Japan,
Nos. 41-50 (in Japanese).

Memoirs of the Imperial Geological Survey of Japan,
Nos. 1-2.

Reports of the Mineral Survey,
No.. 15-20.

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(5) MINERALS

The specimens, here exhibited, are a portion of the collection of the Imperial Geological Survey of Japan. They include nearly all the mineral species so far as found in Japan, and are classified according to Prof. **DANA'S** system with their corresponding localities as follows:

I. NATIVE ELEMENTS

No.	Name	*Locality*
1.	Graphite	*Chinotani, Etchu.*
2.	Sulphur	*Shiranesan, Kōzuke.*
3.	„	*Yonago, Shinano.*

No.	Name	Locality
4.	Arsenic	*Akadani, Echizen.*
5.	Bismuth	*Ikuno, Tajima.*
6.	Gold	*Kanayamadani, Hida.*
7.	Silver	*Ikuno, Tajima.*
8.	Copper	*Osarizawa, Rikuchū.*
9.	Iridosmine	*Sorachi, Ishikari.*

II. SULPHIDES

10.	Realgar	*Nishimaki, Kōzuke.*
11.	Orpiment	*Jōzankei, Ishikari.*
12.	Bismuthinite	*Sannotake, Buzen.*
13.	Molybdenite	*Hagimachi, Hida.*
14.	Galena	*Ani, Ugo.*
15.	„ and Sphalerite	*Shiraita, Echigo.*
16.	Argentite	*Handa, Iwashiro.*
17.	Chalcosite after Galena	*Arakawa, Ugo.*
18.	Sphalerite	*Shiraita, Echigo.*
19.	Covelline	*Kosaka, Rikuchū.*
20.	Pyrrhotite	*Yoshioka, Bitchū.*
21.	Chalcopyrite	*Arakawa, Ugo.*
22.	Iron Pyrites	*Nagamatsu, Uzen.*
23.	„	*Akadani, Echigo.*
24.	Cobaltite	*Naganobori, Nagato.*
25.	Gersdorffite	*Natsume, Tajima.*
26.	Marcasite	*Osarizawa, Rikuchū.*
27.	Arsenopyrite	*Otomezaka, Kai.*

III. SULPHO-SALTS

28.	Jamesonite	*Kuratani, Kaga.*
29.	Tetrahedrite and Galena.	*Yuzata, Kōzuke.*
30.	Enargite	*Kinkwaseki, Taiwan.*

IV. HALOID

31.	Fluorite	*Hōtatsuzan, Noto.*

V. OXIDES

No.	Name	*Locality*
32.	Rock Crystal	*Ogani, Uzen.*
33.	„ (Twinned)	*Otomezaka, Kai.*
34.	„	*Kinpōzan, Kai.*
35.	Amethyst	*Obara, Iwaki.*
36.	Smoky quartz	*Yamanō, Hitachi.*
37.	Chalcedony	*Ogani, Uzen.*
38.	Siliceous Oolite	*Tateyama, Etchu.*
39.	Tridymite	*Ishigamiyama, Higo.*
40.	Precious Opal	*Hōsaka, Iwashiro.*
41.	Cuprite	*Arakawa, Ugo.*
42.	Sapphire	*Naegi, Mino.*
43.	Specular Iron	*Sennin, Rikuchū.*
44.	„	*Akadani, Echigo.*
45.	Magnetite	*Kamaishi, Rikuchū.*
46.	Cassitelite	*Takayama, Mino.*

VI. CARBONATES

47.	Iceland Spar	*Kanagidaira, Musashi.*
48.	Calcite	*Nakase, Tajima.*
49.	Siderite	*Ōmori, Iwami.*
50.	Rhodochrosite	*Kuratani, Kaga.*
51.	Smithonite	*Hosokura, Rikuzen.*
52.	Aragonite	*Kazunoya, Shinano.*
53.	Malachite	*Ani, Ugo.*
54.	„	*Naganobori, Nagato.*

VII. SILICATES

55.	Orthoclase	*Takayama, Mino.*
56.	„ and Smoky Quartz	*Tanokamiyama, Ōmi.*
57.	„	*Miyamoto, Kai.*
58.	Anorthite	*Miyakejima, Izu.*
59.	Hedenbergite	*Obira, Bungo.*
60.	Augite	*Nishinotake, Hizen.*

No.	Name	Locality
61.	Actinolite	*Yoshino, Tosa.*
62.	Hornblende	*Sabōzan, Taiwan.*
63.	Beryl	*Tanokamiyama, Ōmi.*
64.	Cordierite	*Kakihana, Tanba.*
65.	Garnet	*Yamanō, Hitachi.*
66.	Olivine	*Nishinotake, Hizen.*
67.	Vesuvianite	*Kiura, Bungo.*
68.	Naegite	*Naegi, Mino.*
69.	Danburite	*Obira, Bungo.*
70.	Topaz	*Takayama, Mino.*
71.	Andalusite	*Mujinamori, Iwaki.*
72.	Epidote	*Takeshi, Shinano.*
73.	Axinite	*Noborio, Hyūga.*
74.	„	„ „
75.	Lievrite	*Hinodedani, Echigo.*
76.	Tourmaline	*Ishikawa, Iwaki.*
77.	Apophyllite	*Maze, Echigo.*
78.	Muscovite	*Ryūminzan, Chōsen.*
79.	Lepidolite	*Tsuchiya, Chikuzen.*
80.	Talc	*Ōgushi, Hizen.*

VIII. TITANO-SILICATE

81.	Titanite	*Futatsuya, Hida.*

IX. NIOBATES, TANTALATES

82.	Fergusonite	*Naegi, Mino.*
83.	Columbite	*Ishikawa, Iwaki.*

X. PHOSPHATES, ARSENATES

84.	Monazite	*Ishikawa, Iwaki.*
85.	Apatite	*Masutomi, Kai.*
86.	Pyromorphite	*Kamioka, Hida.*
87.	Vivianite	*Ashio, Shimotsuke.*

XI. SULPHATES

No.	Name	Locality
88.	Barite	*Tsubaki, Ugo.*
89.	Linarite	*Kamioka, Hida.*
90.	Selenite	*Hanaoka, Ugo.*

XII. TUNGSTATES

91.	Scheelite	*Kaga, Suō.*
92.	Reinite	*Otomezaka, Kai.*

SPECIMENS of LARGE SIZE

308.	Stibnite	*Ichinokawa, Iyo.*
309.	„	„ „
310.	Molybdenite	*Uchiyama, Etchū.*
311.	Sphalerite	*Shiraita, Echigo.*
312.	Chalcopyrite	*Ogoya, Kaga.*
313.	Rock Crystal	*Otomezaka, Kai.*
314.	Smoky Quartz	*Sugazawa, Hōki.*
315.	Quartz after Barite	*Arakawa, Ugo.*
316.	Orthoclase	*Kimpūzan, Kai.*
317.	Amazonstone	*Tadachi, Shinano.*
318.	Axinite	*Obira, Bungo.*
319.	Reinite	*Otomezaka, Kai.*
320.	Hokutolite	*Hokuto, Taiwan.*

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(6) ROCKS

The specimens, here exhibited, include most of the typical rocks found in Japan, and are arranged according to their geological formations and eruptive rocks with corresponding localities as follows:

I. METAMORPHIC ROCKS

1. Gneiss

No.	Name	Locality
93.	Granite-gneiss	*Ichinose, Shinano.*
94.	Biotite-gneiss	*Sōri, Iwaki.*
95.	Amphibole-gneiss	*Tamadare, Hitachi.*
96.	Titanite-amphibole-schist	*Sōri, Iwaki.*
97.	Limestone	*Nishiyama, Iwaki.*

2. Crystalline schist

98.	Spotted Sericite-schist	*Miye, Hizen.*
99.	Porphyritic Sericite-gneiss	,, ,,
100.	Sericite-schist	*Tokushima, Awa (Shikoku).*
101.	Piedmontite-schist	,, ,, (,,)
102.	Glaucophane-schist	,, ,, (,,)
103.	Spotted Chlorite-amphibolite	*Yanaze, Musashi.*
104.	Graphite-schist	*Onishi, Kōzuke.*
105.	Andalusite-muscovite-schist	*Hitachi, Hitachi.*

II. SEDIMENTARY ROCKS

1. Palæozoic

106.	Pyroxenite	*Yazurihara, Kōzuke.*
107.	Amphibolite	*Mihara,* ,,
108.	Limestone	*Sukegawa, Hitachi.*
109.	Schalstein	*Manba, Kōzuke.*
110.	,,	*Takōzu, Rikuchū.*
111.	,,	*Nakanose, Awa (Shikoku).*
112.	Hornstone	*Aihara, Kōzuke.*
113.	Greywacke	*Miyazawa,* ,,
114.	Clayslate	*Ashio, Shimotsuke.*
115.	Limestone	*Akasaka, Mino.*
116.	,,	,, ,,

No.	Name	Locality
117.	Limestone	*Akasaka, Mino.*
118.	„	„ „
119.	Ottrelite-schist	*Miyata, Hitachi.*
120.	Micaceous Sandstone	*Wagama, Rikuchu.*
121.	Cordierite-slate	*Sengenyama, Hitachi.*

2. *Mesozoic*

122.	Schalstein	*Asa, Nagato.*
123.	Conglomerate	*Ryōseki, Tosa.*
124.	Sandstone	*Asa, Nagato.*
125.	Clayslate	*Nariwa, Bitchū.*
126.	Limestone	*Nomura, Iyo.*
127.	Sandstone	*Minato, Awaji.*

3. *Cainozoic* (*Tertiary*)

128.	Liparite-tuff	*Kinosaki, Tajima.*
129.	Sandstone	*Kamiohara, Awa (Shikoku).*
130.	Conglomerate	*Yoshida, Musashi.*
131.	Shale	*Shiobara, Shimotsuke.*
132.	Limestone	*Hahajima, Ogasawarajima.*
133.	Diatom Earth	*Nogami, Bungo.*

III. ERUPTIVE ROCKS

134.	Granitite	*Ionoshō, Suō.*
135.	Two-mica-granite	„ „
136.	Hornblende-granite	*Gogoshima, Iyo.*
137.	Graphic Granite	*Ukishima, Suō.*
138.	Porphyritic Granite	*Ishikawayama, Iwaki.*
139.	Quartz-porphyry	*Ashio, Shimotsuke.*
140.	Quartz-diorite	*Nakagawa, Sagami.*
141.	Diorite	*Kawanami, Iwami.*
142.	Corsite	*Shiraishi, Iwaki.*
143.	Gabbro-diorite	*Tsukuba, Hitachi.*
144.	Peridotite	*Machiya, „*
145.	Gabbro	*Kaisuka, Awa (Honshū).*
146.	Norite	*Shioda, Awaji.*

No.	Name	Locality
147.	Ophicalcite	*Kanagasaki, Musashi.*
148.	Diabase	*Mane, Musashi.*
149.	Hornblende-porphyrite	*Akamagaseki, Nagato.*
150.	Liparite	*Iwatsune, Inaba.*
151.	Piedmontite-liparite	*Karaisawashinden, Shimano.*
152.	Liparite	*Futami, Tajima.*
153.	Spherulitic Liparite	*Aoki, Iwashiro.*
154.	Trachyte	*Matsushima, Hizen.*
155.	Liparitic-obsidian	*Himejima, Bungo.*
156.	Dacite	*Enoura, Suruga.*
157.	Propylite	*Arari, Izu.*
158.	Two-pyroxene-andesite	*Chōkaizan, Uzen.*
159.	„	*Tōnosawa, Sagami.*
160.	Hornblende-andesite	*Himejima, Bungo.*
161.	Mica-hornblende-andesite	*Yura, Sanuki.*
162.	Mica-andesite	*Sambegama, Iwami.*
163.	Olivine-pyroxene-andesite	*Nikkō, Shimotsuke.*
164.	Andesite-obsidian	*Ikadaba, Izu.*
165.	Obsidian	*Tokachigawa, Tokachi.*
166.	Sanukite	*Kokubu, Sanuki.*
167.	Boninite	*Ogasawarajima.*
168.	Basalt	*Tomie, Hizen.*
169.	Plagioclase-basalt	*Daikonjima, Izumo.*
170.	Mica-bearing Basalt	*Shimonoseki, Nagato.*
171.	Mud Lava	*Obi, Hyūga.*

COLLECTION OF ROCK SPECIMENS OF THE VOLCANO ASO.

I. LAVAS OF SOMMA

237.	Two-pyroxene-andesite	*Tateno.*
238.	„	„
239.	„	*Takamori.*

No.	Name	*Locality*
240.	Hornblende-pyroxene-andesite	*Kabutoiwa.*
241.	„	„
242.	Two-pyroxene-andesite	„
243.	„	*Ontake.*
244.	Olivine-andesite	*Toshita.*

II. LAVAS OF CENTRAL CONES

245.	Glassy Two-pyroxene-andesite (Eboshidake Lava)	*Eboshidake.*
246.	„ „	„
247.	Two-pyroxene-andesite Glass (Eboshidake Lava)	*Tochinoki.*
248.	Two-pyroxene-andesite (Eboshidake Lava)	„
249.	„ „	„
250.	„ „	*Tarutama.*
251.	„ (Okamado Lava)	*Okamado.*
252.	Olivine-andesite (Ōjōdake Lava)	*Ōjōdake.*
253.	Glassy Two-pyroxene-andesite (Yomine Lava)	*Yomine.*
254.	„ „	„
255.	Olivine-augite-andesite (Kishimadake Lava)	*Kishimadake.*
256.	„ (Nakadake Lava)	*Nakadake.*
257.	Augite-andesite (Nakadake Lava)	„

No.	Name	Locality
258.	Augite-andesite (Nakadake Lava)	*Maruyama, Nakadake.*
259.	„ „	„ „
260.	Glassy Two-pyroxene-andesite (Nakadake Lava)	*Nabegajō, Nakadake.*
261.	Olivine-pyroxene-andesite (Nakadake Lava)	*Miike.* „
262.	Two-pyroxene-andesite (Nakadake Lava)	„ „
263.	Augite-andesite (Nakadake Lava)	*Ichiseki.* „
264.	Olivine-pyroxene-andesite (Takadake Lava)	*Takadake.*
265.	Hornblende-pyroxene-andesite (Nekodake Lava)	*Nekodake.*
266.	Two-pyroxene-andesite (Nekodake Lava)	„

III. EJECTA OF NAKADAKE

267.	Ejecta	*Nakadake.*
268.	„	„
269.	„ (Dish-stone)	„
270.	Lapilli	„
271.	Volcanic Sand	„

COLLECTION OF ROCK SPECIMENS OF THE VOLCANO SAKURAJIMA

I. LAVAS (1914—Taishō)

272.	Pyroxene-andesite	*Kurokami.*
273.	„	*Arimura.*

No.	Name	Locality
274.	Pyroxene-andesite	*Arimura,*
275.	Pumiceous Lava	,,
276.	,,	*Hakamagoshi.*
277.	,,	*Hikinohira.*

II. EJECTA (1914—Taishō)

278.	Ejecta	*Hikinohira.*
279.	,,	*Kurokami.*
280.	,,	*Koike.*
281.	,,	*Hakamagoshi.*
282.	,,	*Nabegama.*
283.	Pumice	*Fumoto.*
284.	Volcanic Ashes	*Kokubu.*

III. LAVAS (1779—An-ei and 1476—Bunmei)

285.	Pyroxene-andesite	(1779)	*Kurokami.*
286.	,,	,,	*Furusato.*
287.	,,	(1476)	*Mochiki.*

IV. LAVAS (*ante* 1476)

288.	Pyroxene-andesite	*Mochiki.*
289.	,,	*Yunohama.*
290.	,,	*Uramomae.*
291.	,,	*Kōmen.*
292.	,,	*Yurigamachihara.*
293.	Olivine-pyroxene-andesite	*Tatsusaki.*
294.	Pyroxene-andesite	*Kuramonzaki.*
295.	,,	*Hikinohira.*
296.	Glassy Pyroxene-andesite	*Furihata.*
297.	Pyroxene-andesite	*Marutsuka.*

V. ROCKS OF DEPENDENT ISLES

298.	Tuff	*Hakamagoshi.*

No.	Name	Locality
299.	Pyroxene-andesite	*Niijima.*
300.	,,	*Sejima.*
301.	Hornblende-liparite	*Okoshima.*
302.	Liparite Glass	*Enoshima.*

VI. ROCKS OF OSUMI PENINSULA

303.	Liparite Glass	*Sakkabira.*
304.	Augite-andesite	*Tobashirihana.*
305.	Pyroxene-andesite	*Obama.*
306.	Liparite	*Fumoto.*
307.	Clayslate	*Waki.*

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(7) FOSSILS

The following are some of the characteristic fossils hitherto found in Japan, and represent the Japanese types of fossils embedded in the strata, ranging from the Carboniferous to the Tertiary. They are arranged according to their geological ages with their corresponding localities as follows:

I. PALÆOZOIC

Carboniferous

172.	Fusulina sp.	*Tomuro, Shimotsuke.*
173.	Schwagerina globosa *Yabe.*	*Akasaka, Mino.*
174.	Fusulina sp. and Schwagerina sp.	,, ,,
175.	Lonsdaleia akasakaensis *Yabe.*	,, ,,
176.	Favosites sp.	*Tsukitate, Rikuzen.*
177.	Crinoid sp.	*Akasaka, Mino.*

II. MESOZOIC

1. *Triassic*

No.	Name	Locality
178.	**Pseudomonotis ochotica** (*Keyserl*) *Teller*	*Nariwa, Bitchū.*
179.	**Ceratites sakawanus** *E. v. Mojs.*	*Sakawa, Tosa.*
180.	**Arpadites (Anorcites) Gottschei** *E. v. Mojs.*	*Inai, Rikuzen.*
181.	**Dictyophyllum japonicum** *Yok.*	*Yamanoi, Nagato.*
182.	**Asplenium Rœsserti** *Presl.*	,, ,,

2. *Jurassic*

183.	**Pentacrinus** sp.	*Aohama, Buzen.*
184.	**Trigonia V-costata** *Lyc.*	*Hosoura, Bikuch .*
185.	**Corbicula** sp.	*Kurouchi, Hida.*
186.	**Perisphinctes** sp.	*Nagano, Echizen.*
187.	**Thyrsopteris kagaensis** *Yok.*	*Ogamigō, Hida.*
188.	**Dicksonia elongate** *Geyl.* sp. var.	*Hakogase, Echizen.*
189.	**Asplenum whitbiense** *Brgt.*	*Ryōseki, Tosa.*
190.	**Pecopteris** cfr. **Browniana** *Dk.*	*Tanano, Awa (Shikoku).*
191.	**Nilssonia nipponensis** *Yok.*	*Okamigō, Hida.*
192.	**Dioonites Kotoei** *Yok.*	*Tani, Echizen.*
193.	**Baiera Heeri** *Yok.*	*Shima, Kaga.*
194.	**Dictiozamites indicus** *Fstm.*	,, ,,
195.	**Ginkgodium lepida** *Hr.*	*Hakogase, Echizen.*

3. *Cretaceous*

196.	**Thamnastræa** sp.	*Shiraishi, Tosa.*
197.	**Inoceramus Naumanni** *Yok.*	*Urakawa, Hidaka.*
198.	**Inoceramus ezoensis** *Yok.*	,, ,,

No.	Name	Locality
199.	Avicula Haradæ *Yok.*	*Kagahara, Kōzuke.*
200.	Cyrena (Corbicula) sp.	" "
201.	Trigonia pocilliformis *Yok.*	" "
202.	Capulus cassidarius *Yok.*	*Urakawa, Hidaka.*
203.	Phylloceras ramosum *Meek.*	*Pankekenebetsu, Teshio.*
204.	Hamites yūbariensis *Yabe*	*Yūbari, Ishikari.*
205.	Anisoceras Haradanum *Yok.*	*Abeshinai, Teshio.*
206.	Ptychoceras Pseudo-gaultinum *Yok.*	*Urakawa, Hidaka.*
207.	Pachydiscus Haradai *Jimbō.*	*Abeshinai, Teshio.*
208.	Desmoceras Damesi *Jimbō.*	" "
209.	Puzosia planulatiforme *Jimbō*	" "
210.	Lytoceras tenuiliratum *Yabe*	*Soshibetsu, Iburi.*
211.	Lytoceras Sacya *Forbes.*	*Yubarigawa, Ishikari.*
212.	Pecopteris cfr. Browniana *Dk.*	*Tanano, Awa (Shikoku).*
213.	Pecopteris Geyleriana *Nath.*	*Ryōseki, Tosa.*
214.	Chladophlebis Nathorsti *Yok.*	" "
215.	Zamiophyllum Buchianum *Ett.*	" "
216.	Nilssonia pterophylloides *Yok.*	" "

III. CAINOZOIC

Tertiary

217.	Nummulite baguelensis *Verb.*	*Habajima, Ogasawarajima.*
218.	Nummulites javanus *Verb.*	" "
219.	Orbitoides sp.	*Oishi, Kai.*
220.	Pentacrinus stem	*Kushimoto, Kii.*
221.	Schizaster nummuliticus *Yosh.*	*Habajima, Ogasawarajima.*
222.	Linthia nipponica *Yosh.*	*Sanagosawa, Uzen.*
223.	Echinarachnius mirabilis *A. Ag.*	*Sawane, Sado.*
224.	Rhynchonella psittacea *Gmel.*	*Miyata, Hitachi.*

No.	Name	Locality
225.	Terebratulina caput-serpentis *L.*	*Miyata, Hitachi.*
226.	Mytilus edulis *Linn.*	*Piraudo, Hidaka.*
227.	Conchocele disjuncta *Gabb.*	*Itsuura, Hitachi.*
228.	Vicarya callosa *Martens*	*Tsukiyoshi, Mino.*
229.	Oxyrhina sp.	*Nagakubo, Mutsu.*
230.	Lamna sp.	*Shirahama, Izu.*
231.	Carpiniphyllum pyramidale *Göp.* sp. japonicum	*Asano, Shinano.*
232.	Fagus japonica *Max.*	*Shiobara, Shimotsuke.*
233.	Planera Ungeri *Ett.*	*Ani, Ugo.*
234.	Taxodum distichum *Rich.*	*Kosasa, Hizen.*
235.	Acer palmatum *Th.*	*Shiobara, Shimotsuke.*
236.	Trapa dainipponica *Yok.*	*Ogoya, Kaga.*

SPECIMENS OF LARGE SIZE

321.	Helicoprion Bessonowi *Karp.*	*Mizunuma, Kōzuke.*
322.	Pleurotomaria sp.	*Akasaka, Mino.*
323.	Bellerophon sp.	" "
324.	Onychiopsis elongata *Geyl.* Podozamites lanceolatus *Lind.* Podozamites Reinii *Geyl.*	*Shima, Kaga.*
325.	Nilssonia pterophylloides *Yok.*	*Yuasa, Kii.*
326.	Ginkgodium Nathorsti *Yok.*	*Shima, Kaga.*
327.	Phylloceras Velledæ *Michelin*	*Mombetsu, Hidaka.*
328.	Pachydiscus Naumanni *Yok.*	*Urakawa, Hidaka.*
329.	Platyptera sp.	*Shiobara, Shimotsuke.*
330.	Carcharodon sp.	*Monzen, Echigo.*
331.	Stegodon Clifti *Falc. et Caut.*	*Shōdojima, Sanuki.*
332.	Elephas meridionalis *Nesti.*	*Mino.*

(8) LAVAS AND BOMBS SINCE 1909

Since 1909 some large volcanic eruptions have taken place among the volcanoes of the Japanese Empire. Except a few cases as in the eruption of the volcano Usu in 1910, large volcanic bombs and blocks have been ejected during the eruption, often followed by lava flow. In January 1914 an enormous lava flow issued from newly formed craters on the slope of the volcano Sakurajima, and in 1912 a small volume of lava flowed out on the crater bottom of the central cone of the volcano Mihara. In 1909 lava issued out from the crater bottom of the central cone of the volcano Tarumae, so as to form a dome on the old crater bottom. Large blocks of lava have been ejected from the central crater of the volcano Asama during eruption of 1909, while volcanic bombs of various shapes and sizes have been ejected in the eruption of the volcano Tarumae in 1909, of the volcano Mihara in 1912 and of the volcano Sakurajima in 1914. Beside lavas and bombs since 1909, volcanic bombs of the volcano Sakurajima, ejected in 1779 (An-ei) and lava stalactite, ropy lava and volcanic bombs of the volcano Fuji were also exhibited.

No.	Name	*Locality*
333.	Lava (1909)	*Tarumaegama, Ibari.*
334.	„ „	*Asamagama, Shinano.*
335.	„ (1912)	*Miharagama, Izu.*
336.	„ „	„ „
337.	„ (1914)	*Sakurajima, Satsuma.*
338.	„ „	„ „
339.	Bomb (1909)	*Tarumaegama, Ibari.*
340.	„ (1912)	*Miharagama, Izu.*
341.	„ (1914)	*Sakurajima, Satsuma.*
342.	„ „	„ „
343.	„ „	„ „
344.	„ „	„ „
345.	Lava Stalactite	*Fujisan, Suruga.*
346.	Lava	„ „
347.	Bomb	„ „
348.	„	„ „

No.	Name	Locality
349.	Bomb	*Miharayama, Izu.*
350.	„ (1779)	*Sakurajima, Satsuma.*
351.	„ „	„ „

(9) COPPER ORES OF THE PRINCIPAL COPPER MINES (showing the structures)[1]

Metasomatic Deposits

352.	*Kosaka,*	*Rikuchū.*	357.	*Kunitomi,*	*Shiribeshi.*
353.	„	„	358.	„	„
354.	„	„	359.	*Hanaoka,*	*Ugo.*
355.	*Abeshiro,*	*Mutsu.*	360.	„	„
356.	„	„			

Veins

361.	*Ikuno,*	*Tajima.*	367.	*Osaruzawa,*	*Rikuchū*
362.	*Ogoya,*	*Kaga.*	368.	*Ani,*	*Ugo*
363.	*Yūsenji,*	„	369.	*Arakawa,*	„
364.	*Ashio,*	*Shimotsuke.*	370.	„	„
365.	„	„	371.	*Hisaichi,*	„
366.	*Osaruzawa,*	*Rikuchū.*			

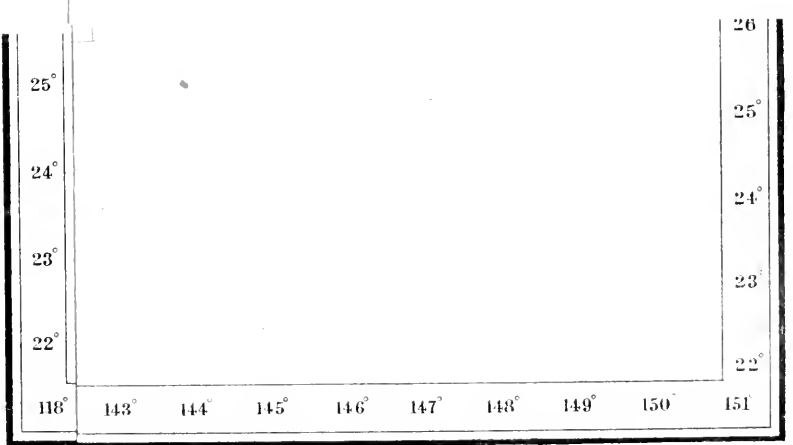
Contact Deposits

372.	*Kamaishi,*	*Rikuchū.*	374.	*Obie,*	*Bitchū.*
373.	*Yaguki,*	*Iwaki.*	375.	*Yoshioka,*	„

Beds

376.	*Hitachi,*	*Hitachi.*	380.	*Kane,*	*Tōtōmi.*
377.	„	„	381.	*Hibira,*	*Hyūga.*
378.	*Besshi,*	*Iyo.*	382.	*Makimine.*	„
379.	„	„			

1 Refer page 38 (Copper Mines of Japan).



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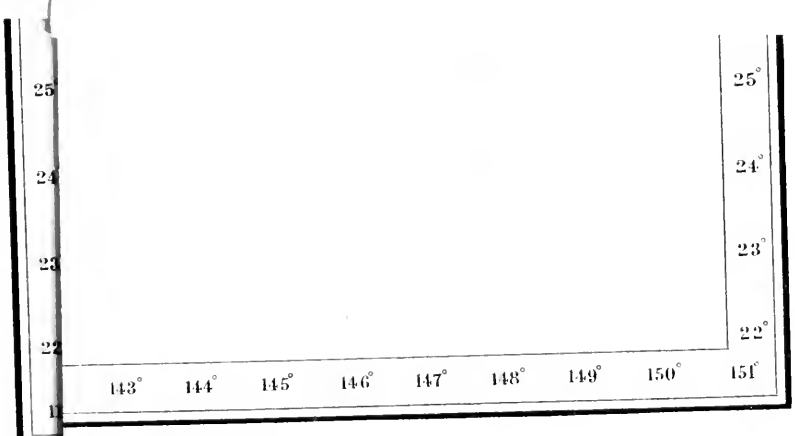

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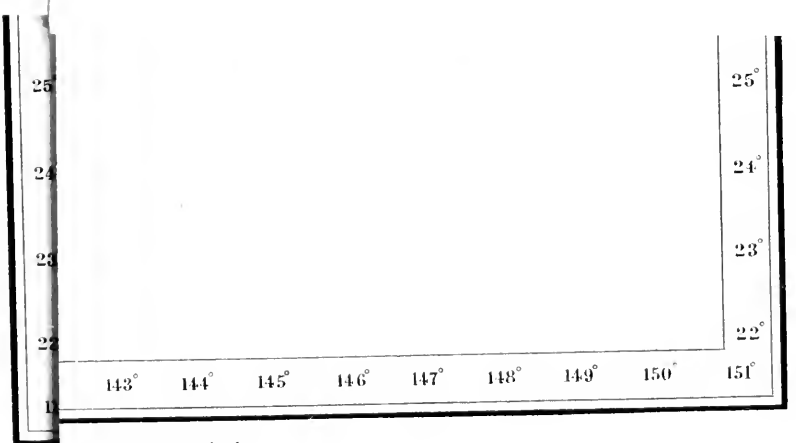

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